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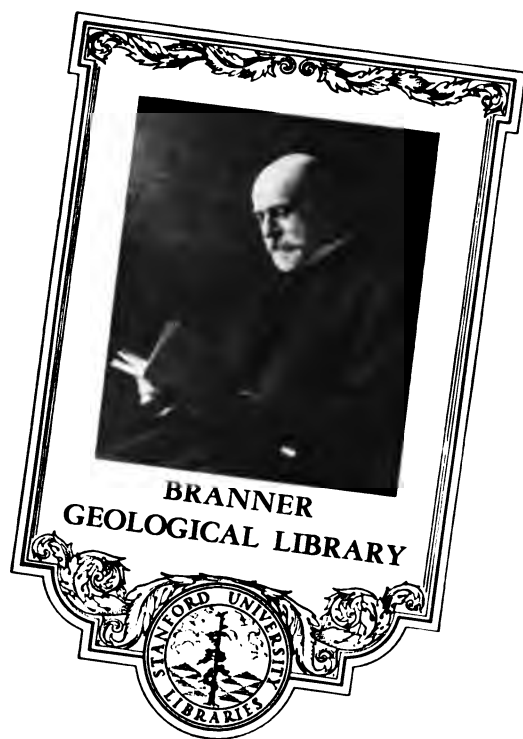
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PROCEEDINGS

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OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

Vol. V

1915

SAN FRANCISCO  
PUBLISHED BY THE ACADEMY  
1915

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BARTON WARREN EVERMANN, *Editor*

# CONTENTS OF VOLUME V.

## PLATES 1-19.

	PAGE
Title-page .....	i
Contents .....	iii
Report of the President of the Academy for the Year 1914. By C. E. Grunsky .....	1
(Published March 26, 1915)	
Report of the Director of the Museum for the Year 1914. By Barton Warren Evermann .....	11
(Published March 26, 1915)	
Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington. By Roy E. Dickerson. (Plates 1-11) .....	33
(Published June 15, 1915)	
A List of the Amphibians and Reptiles of Utah, with Notes on the Species in the Collection of the Academy. By John Van Denburgh and Joseph R. Slevin. (Plates 12-14) .....	99
(Published June 15, 1915)	
Description of a New Subgenus ( <i>Arborimus</i> ) of <i>Phenacomys</i> , with a Contribution to Knowledge of the Habits and Distribution of <i>Phenacomys longicaudus</i> True. By Walter P. Taylor. (Plate 15) .....	111
(Published December 30, 1915)	
Tertiary Deposits of Northeastern Mexico. By E. T. Dumble. (Plates 16-19) .....	163
(Published December 31, 1915)	
Report of the President of the Academy for the Year 1915. By C. E. Grunsky .....	195
(Published May 4, 1916)	
Report of the Director of the Museum for the Year 1915. By Barton Warren Evermann .....	203
(Published May 4, 1916)	
Index .....	225, 232

July 19, 1916



**PROCEEDINGS**  
**OF THE**  
**CALIFORNIA ACADEMY OF SCIENCES**  
**FOURTH SERIES**

**VOL. V, Nos. 1 and 2, pp. 1—31**

**MARCH 26, 1915**

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**I.**

**REPORT OF THE PRESIDENT OF THE ACADEMY  
FOR THE YEAR 1914**

By **C. E. GRUNSKY**  
President of the Academy

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**MEMBERSHIP**

The present total membership in the Academy is 447, made up of:

Honorary Members .....	30
Life Members .....	83
Resident Members .....	334

During the year 1914 there was an accession of 10 new members, and the Academy lost by death 10, by resignation 37, and by being dropped for arrearages in dues, 11. The net loss in membership during the year has been 48.

The losses by death were:

W. C. Barnard .....	Resident Member.....	June 5,	1914
Prof. Samuel B. Christy....	Life	"	..... November 30, "
F. W. Dohrmann .....	Resident	"	..... July 18, "
Chas. Fuchs .....	"	"	..... June 11, "
Dr. Theo. N. Gill.....	Honorary	"	..... September 25, "
Prof. E. S. Holden .....	Life	"	..... March 16, "
C. A. Hooper .....	Resident	"	..... July 12, "
John H. W. Husing .....	"	"	..... January 31, "
Thomas Magee .....	"	"	..... May 30, "
J. G. Spaulding .....	"	"	..... March 29, "

March 24, 1915

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11. The large collection of beetles belonging to the late Charles Fuchs, for many years the Academy's assistant curator of entomology, has been deposited with the Academy by Mrs. Fuchs, and an effort is being made to secure funds for its purchase.

The additions to the herbarium have been many and important, representing hundreds of specimens among which are many genera and species new to the herbarium. Among the most important additions may be mentioned the following:

12. A collection of 278 specimens representing 28 genera and 75 species of ferns chiefly from Massachusetts and the vicinity of Washington, D. C., donated by Mr. H. W. Henshaw of Washington, D. C.

13. A very large collection, especially rich in willows, made by Miss Eastwood in the Yukon region during the spring and summer of 1914.

14. Considerable collections of plants made by Miss Eastwood in March in Kern, Tulare and Contra Costa counties, California.

15. Large miscellaneous collections sent in from time to time by Mr. L. E. Smith, from the upper Sacramento Valley.

16. Numerous specimens, chiefly exotics, have been donated from time to time by Mr. G. P. Rixford.

17. Large collections of Japanese and Chinese plants have been received from Dr. Fred Baker and Mrs. Charlotte Baker, of San Diego, Cal.

18. A great many specimens adding many families, genera and species to the herbarium, have been received from the Director of the Philippine herbarium.

Miss Eastwood, the curator of botany, has been indefatigable in receiving and caring for the collections. In mounting the specimens, she has received great assistance from Mrs. Marian L. Campbell who has most generously given to the herbarium a day or more of her time nearly every week during the fall and winter.

Miss Eastwood conducts a botanical club of about 50 members which meets usually about once a week. She also meets once a week with the park gardeners and gives them instruction regarding the plants under their care. This is educational work of real value and should be encouraged.

## ACCESSIONS TO THE LIBRARY

There have been the usual accessions to the library resulting from purchase, subscriptions to periodicals, and from exchanges. There have also been many donations as set forth in the appendix to the Director's report. Only a few of the more important donations will be mentioned here.

1. A collection of about 200 volumes and pamphlets from the late Professor William Eimbeck, received through Captain Ferdinand Westdahl of the United States Coast and Geodetic Survey.

2. Through the courtesy of Senator Geo. C. Perkins the library now receives regularly the Congressional Record, as issued.

3. The Director has presented to the library a bound set of the Proceedings of the Washington Academy of Sciences. This set comprises Volumes I-XIII, and is complete.

4. Mr. Horace Davis has presented to the library a complete original set of the publications of the Academy. The volumes are handsomely and substantially bound and constitute the most perfect set of the Academy's publications which it possesses.

5. A large number of pamphlets from the Gray Herbarium, among them many of the papers by Professor Asa Gray and Professor Sereno Watson.

6. Thirty-one numbers of the Journal of Morphology, from the Wistar Institute.

7. About 40 early numbers of the Proceedings of the California Academy of Sciences from Professor W. G. Farlow.

## PUBLICATIONS

The Academy has published during 1914 five papers: One is No. X (Proc., 4th Ser., Vol. II, Part 1) of the series relating to the Expedition to the Galapagos Islands, and the other four are in continuation of Vol. IV, Fourth Series of the Proceedings, as follows:

*The Gigantic Land Tortoises of the Galapagos Archipelago.*

By John Van Denburgh. Fourth Series, Vol. II, No. X, pp. 203-374, plates 12-124. Published September 30, 1914.

*Report of the President of the Academy for the year 1913; and George Davidson.* Fourth Series, Vol. IV, Nos. I and II, pp. 1-13. Published April 8, 1914.

*Neocene Record in the Temblor Basin, California, and Neocene Deposits of the San Juan District, San Luis Obispo County.* By Frank M. Anderson and Bruce Martin. Fourth Series, Vol. IV, No. 3, pp. 15-112, plates 1-10. Published December 30, 1914.

*The Fauna of the Siphonalia sutterensis Zone in the Roseburg Quadrangle, Oregon.* By Roy E. Dickerson. Fourth Series, Vol. IV, No. 4, pp. 113-128, plates 11 and 12. Published December 30, 1914.

*Reptiles and Amphibians of the Islands of the West Coast of North America.* By John Van Denburgh and Joseph R. Slevin. Fourth Series, Vol. IV, No. 5, pp. 127-152. Published December 30, 1914.

*The Pocket Gopher of the Boreal Zone on San Jacinto Peak.* By J. Grinnell and H. S. Swarth. Fourth Series, Vol. IV, No. 6, pp. 153-160. Published December 30, 1914.

The Academy also published on December 30, 1914, Title page and Contents, Vol. I, Mathematics-Physics, Third Series; Title page, Contents and Index, Vol. II, Geology, Third Series; Title page, Contents and Index, Vol. IV, Zoology, Third Series; Title page, Contents and Index, Vol. I, Fourth Series; and Title page, Contents and Index, Vol. III, Fourth Series. These complete in this respect all the volumes to date.

#### LECTURES

During the year 1914, 19 free lectures have been delivered at the stated meetings of the Academy, as follows:

FEBRUARY 2. "Poisonous reptiles of the Pacific Coast."

Dr. John Van Denburgh, Curator of Herpetology.

FEBRUARY 12. "Necessity for care in the determination of type specimens."

Bruce Martin, Asst. Curator of Invertebrate Paleontology.

MARCH 2. "Fertilization of the Smyrna Fig."

G. P. Rixford.

MARCH 16. "The last appearance of the Leonids."

C. E. Grunsky, President of the Academy.

- APRIL 6. "Specialization in the Protozoa and suggestions of Metazoan Origin."  
Prof. C. A. Kofoed, University of California.
- APRIL 20. "Origin of petroleum."  
F. M. Anderson, Curator of Invertebrate Paleontology.
- MAY 4. "Geological history of California."  
Dr. John Perrin Smith, Stanford University.
- MAY 18. "Myths and songs of the Sierras."  
Edward W. Gifford, University of California.
- JUNE 1. "Effect of a strictly vegetable diet on certain animals."  
Dr. J. Rollin Slonaker, Assistant Professor of Physiology, Stanford University.
- JUNE 15. "The Alaska fur-seal herd and its proper management."  
Dr. Barton W. Evermann, Director of the Museum.
- JULY 6. "Status of California's duck population."  
Dr. Harold C. Bryant, Assistant Curator of Birds, Museum of Vertebrate Zoology.
- JULY 20. "Present conditions and future need of California's wild life."  
Dr. Walter P. Taylor, Curator of Mammals, Museum of Vertebrate Zoology.
- AUGUST 17. "Some experiences in Alaska."  
Alice Eastwood, Curator of Botany.
- SEPTEMBER 21. "Life history of the edible crab."  
Dr. Frank W. Weymouth, Assistant Professor of Physiology, Stanford University.
- OCTOBER 5. "Life of cells outside the body."  
Dr. S. J. Holmes, Professor of Zoology, University of California.
- NOVEMBER 16. "The census of the fur-seal herd."  
Geo. A. Clark, Academic Secretary, Stanford University.
- DECEMBER 7. "Summer on the Forrester Island, Alaska, bird reservation."  
Dr. Harold Heath, Professor of Zoology, Stanford University.
- DECEMBER 21. "Recent progress in determining the motion of bodies of the Solar System."  
Dr. A. O. Leuschner, Professor of Astronomy, University of California.

#### THE DIRECTOR OF THE MUSEUM

The Academy has been fortunate in securing the services of Dr. Barton W. Evermann, who early in the year was appointed Director of the Museum to fill the vacancy caused by the resignation of Mr. G. P. Rixford. He came to us from

Washington, D. C., but not as a stranger, he having at one time been a resident of California and having in recent years had official duties on this coast by reason of his connection with the U. S. Bureau of Fisheries in various capacities since 1891, and in charge of the Alaska Fisheries Service since 1910. He has already rendered valuable service to the Academy and will have an enlarged field of usefulness when the Academy's new building in Golden Gate Park becomes available.

#### THE NEW MUSEUM BUILDING

A year ago it was confidently expected that this new building would be completed before the close of 1914. This has not been realized. It was found during the progress of construction that the principal contractors were not using the full amount of cement called for by their contract, that certain undesirable modifications of the specifications had been orally assented to by the agents of the Academy and that in consequence of these circumstances there was some doubt relating to the wisest procedure to remedy the resulting structural defects in the building. The complications resulting from this situation have interfered with the progress on the building. The matter is not yet finally adjusted but it is expected that a course of procedure will soon be determined on resulting in proper protection of the Academy's interests.<sup>1</sup>

#### GENERAL ACTIVITIES

The work done in the various departments under direction of the curators of these departments will be set forth in the reports of the Director of the Museum and of the curators, and needs no special comment in this report, except to state that the earnest and able work being done is gratifying and deserves the encouragement of this community, of the State, and of the entire Pacific slope. The field in which the Academy is active is large. The Academy is in need of funds for better covering this field and for extending its usefulness.

It is gratifying, therefore, to be able to give special acknowledgment to such donations as the valuable Henry Hemphill collection of shells and the loan of the Fitzhugh Collection of

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<sup>1</sup> Since the above was written all these matters have been adjusted, building operations have been resumed, and it is now believed the building will be completed early in July.

Indian baskets and stone implements, which latter will be placed in the new building and properly displayed without cost to the Academy.

But the time is ripe for a proper and adequate endowment for the work which the Academy has in hand. There is immediate need for a fund of about \$1,000,000 to enlarge the new building in the Park to its intended ultimate dimensions and to provide for a proper display of the material which is available in abundance, and which will quickly find its way to such a building when it becomes known that attractive housing facilities have been provided.

A commission which the Curator of the Department of Botany, Miss Alice Eastwood, received, to make a study and collection of willows in Alaska, resulted in a trip by her last spring of which she has given an interesting account at one of the stated meetings. A large addition of Alaskan flora to the Herbarium of the Academy, is to be noted in this connection.

The Curator of the Department of Invertebrate Paleontology, Mr. F. M. Anderson, is at present away on a year's leave of absence in South America on private business and has taken with him Mr. Bruce Martin. His stay in South America will no doubt result in benefit to the Academy's collections as he has requested and is receiving some financial aid in making collections for the Academy.

The place made vacant by the resignation of the Assistant Curator, Mr. Bruce Martin, has been filled by the appointment of Dr. Roy E. Dickerson.

Death has claimed Mr. Chas. Fuchs who was for many years Assistant Curator and an able worker and diligent collector in the Department of Entomology. The private collection of Mr. Fuchs has been added to the Museum where it is being stored and cared for until otherwise disposed of. In his death the Academy has sustained a distinct loss. No one has yet been appointed to take his place.

The preparation of material for display exhibits has been continued throughout the year and it is along this line—measured by the cost of the work—that the Academy has been most active. This will appear more fully in the report of the Director.

In conclusion, on behalf of the officers of the Academy, I desire to express their gratification in the interest manifested by so many of the members and in the cordial effort put forth to advance the best interests of the Academy, which continues, as in the past, to devote itself to the education of our people along lines of natural history, science and related matters.

I desire to extend to the officers of the Academy thanks for their able and cordial cooperation in Academy affairs and for the many personal sacrifices which they have been called on to make on behalf of the Academy.

## II

REPORT OF THE DIRECTOR OF THE MUSEUM  
FOR THE YEAR 1914

By BARTON WARREN EVERMANN  
*Director of the Museum*

The appointment of the present Director of the Museum of the California Academy of Sciences became effective March 15, 1914. Before coming west he took the opportunity, with the permission of the Council, to visit a number of museums in the east, namely: the American Museum of Natural History in New York, the Museum of the Brooklyn Institute of Arts and Sciences, the Children's Museum in Brooklyn, the Field Museum of Natural History in Chicago, the Museum of the Chicago Academy of Sciences, and the Milwaukee Public Museum. Although already quite familiar with the United States National Museum at Washington, in which institution he had served as honorary curator of the Division of Fishes for a number of years, he devoted several days in the early part of March to a study of methods of caring for collections and installing exhibits, of the types of cases used in the different departments, the methods of museum book-keeping, and many other matters relating to the administration of the affairs of that institution.

In all the institutions visited special attention was given to the educational work which they are doing, and it is believed that much information and many suggestions were obtained which will prove of value to this Academy in the development and management of its Museum.

At the time of the director's arrival in San Francisco, construction work on the new Museum building of the Academy in Golden Gate Park was well under way, and it was confidently believed the building would be ready for occupancy certainly by the beginning of the year 1915. In anticipation of this probability, the Director at once began giving consideration to various matters pertaining to the transfer of the Academy's collections, library and offices, to the new building, and their proper installation therein. Consideration had to be given to many things, among which a few may be mentioned: The available space and its best allotment; provision



for proper lighting, heating and ventilation; provision for proper telephone service; type and arrangement of cases for exhibition groups and specimens, and for research collections; details of arrangement and equipment of lecture room and laboratories; type of book stacks and furniture for library and offices; and the details of many other matters of pressing importance preliminary to the installation of a museum in a new building and the making of provision for its expected growth. All of this required much time and thought.

Through the failure of the concrete and brick contractors to comply with the specifications in their contract, it became necessary to stop the construction work temporarily. This was done on July 13, and building operations have not yet<sup>1</sup> been resumed. It seemed best to defer further action in the selection of cases, book-stacks, and other furnishings until the present building embarrassment has been overcome.

Although those matters are at a temporary standstill, the Academy has not been idle. For details concerning the activities of the respective departments of the Museum reference is made to the formal reports of the curators. It is proper to call attention at this time to some of the special activities which have engaged the attention of the Museum force.

#### SPECIAL ACTIVITIES

1. Early in the spring a proposition was received from Messrs. Miller and Lux to turn over to the Academy, free on board the cars at Buttonwillow, Kern County, Cal., such of the California Valley elk as they might be able to catch from the herd which roams over their Kern County ranch, if the Academy would place them in suitable large Federal, State, and private reservations and parks in the state.

Realizing that under existing conditions this important species of big game is seriously threatened with extermination, and being desirous of assisting in preserving the species, the Academy accepted the offer. Considerable time and attention were given to the matter during the summer and fall. Communications were addressed to the superintendents in control of the Federal and State reservations, and to owners of large

<sup>1</sup> January 4, 1915. Since the above was written the building difficulties have been adjusted, construction work has been resumed, and it is now (March 18) believed the building will be ready for occupancy early in July.

private reservations, parks, and ranches in the state, also to the park commissioners and the Lodges of Elks in all the cities of the state, for the purpose of learning whether they wished any of the elk for the reservations or parks under their control.

It was explained to them that these elk were in great danger of extermination; that Messrs. Miller and Lux were desirous of doing anything in their power to save the species; that the Academy of Sciences is cooperating with Miller and Lux with that object in view; that it is desired to place the elk only in such places as will afford a favorable environment in which the animals will breed and thrive; and that the only expense to those wishing any of the elk would be the freight charges and other expenses incident to shipment, and \$3 dollars per head to meet the expense of clerical work.

The response was immediate. Approval of the proposition was universal. Applications for elk were received from many parts of the state. In order that the elk might be placed only in favorable locations the Director through the courtesy of the Southern Pacific and Santa Fe railroads, was able to visit and personally inspect more than twenty of the proposed reservations and parks, and only those thought to furnish a suitable environment were selected to receive shipments.

Early in October, Messrs. Miller and Lux began preparations for capturing the elk. The plan involved the construction of a corral a quarter of a mile long and half as wide in a large alfalfa field to which it was observed the elk came regularly every night to feed. The corral was built of heavy timbers 12 feet high upon which was placed heavy woven fence-wire nine feet high. A wing one-fourth mile long was run out from each side at the corral entrance. The wire was placed on the wings at once but not on the corral proper until the elk had visited the field several nights and had become quite used to the posts, which they did very promptly. Then the wire was put in place everywhere except at the entrance, and on the night following, after about 150 elk had entered the corral, the wire was put in place across the entrance and the elk were trapped. The next day they were quite restless and about 90 of them broke out. About 60 remained and in a few days became so tame that it was safe to undertake their

capture and transfer to the cattle pens at the railroad station a Buttonwillow.

The actual catching, however, was attended with many difficulties and uncertainties. Two escaped by clearing an eight and one-half foot fence. They came nearer flying than was believed possible for such animals.

In spite of all difficulties, 54 elk were successfully shipped to the following:

	<i>No.</i>
One thousand acre reservation in the Santa Monica Mountains, owned by Mr. J. M. Danziger of Los Angeles..	6
Six hundred and forty acre reservation in the Santa Monica Mountains, owned by Mr. E. L. Doheny of Los Angeles .....	10
San Diego City Park .....	12
Private reservation of several hundred acres adjoining the city park at Riverside, and owned by Mr. S. C. Evans of that city .....	4
Modesto City Park .....	2
California Redwood Park Association, Boulder Creek...	10
Del Monte Park, Seventeen-mile Drive, Monterey.....	10

Not a single loss occurred during shipment.

Reports recently received from these various places state that the elk promptly adapted themselves to the new environment and that they are doing well. It is confidently believed that these elk will reproduce in practically all of these reservations and that ever-increasing herds will result.

The Academy has unfilled orders for about 100 additional head. It is the intention of Messrs. Miller & Lux to undertake the capture of more elk next fall, and it is hoped that all unfilled orders may be supplied.

The degree of success that will be attained can not, however, be predicted; the uncertainties are many and various. In the first place, Miller & Lux may fail in their attempt to capture the animals. And then, even after having been captured, they may break out of the corral; they may escape when being transferred from the corral to the cattle pens; they may break out of the cattle pens; or kill themselves by fighting with each other; or escape when being loaded into the cars; or injure

each other in the cars while in transit; or escape or suffer injury when being unloaded.

The experience of the last season will prove very profitable, however, and it is believed that the undertaking next season will be attended with even a greater measure of success.

2. During the spring and summer, the curator of botany, Miss Eastwood, spent several months on a collecting trip in Alaska and the Yukon Territory, and brought back large and very valuable collections of plants, particularly of willows. The details are set forth in Miss Eastwood's formal report.

3. The curators and assistant curators have been diligent in arranging, cataloguing, caring for, and studying the collections in their respective departments. The inadequate quarters which the Academy now occupies make it impossible to properly arrange the collections, and any study of them is almost impossible.

4. The department of mammalogy has made commendable progress with the preparation of the exhibition groups which are to be installed in the new museum building.

The main exhibition hall of the new building is to be devoted to the large California mammals and the more interesting of the smaller species. This hall will accommodate 10 large habitat groups each 25 feet long, and with a 15-foot plate glass front. There will also be room for 20 smaller habitat groups of the smaller California mammals. The rear exhibition hall will have space for six large habitat groups and 12 small groups of the same size and general character as those in the main hall.

The curator of mammals reports that his taxidermists and preparators now have completed and ready to instal in the new building the following large mammal groups: Black-tail Deer, four seasonal groups,—spring, summer, autumn and winter; California Mule Deer; California Valley Elk; Desert Mountain Sheep; California Antelope; Black Bear; California Mountain Lion; California Sea Lion; Steller's Sea Lion; Leopard Seal; Galapagos Gigantic Tortoise; Farallon bird group; Los Baños bird group; and California coast bird group. These and others in preparation will more than fill the proposed available space.

These groups should be installed as rapidly as possible after the completion of the building. It is believed they will prove a great attraction and indicate to the public that the museum is an educational institution.

#### CARE OF COLLECTIONS

All the collections of the Academy have been regularly and carefully inspected with reference to possible danger from insect pests or other causes.

The mammal, bird, and insect collections were inspected in the summer and again in the fall, and found in satisfactory condition. The materials for the large bird groups were examined in December and found to be in excellent condition. These materials have been transferred from Berkeley to a basement room in the Security Building at 343 Sansome Street. The room is a better one than that in which the collections were previously stored and costs nothing for rent.

#### MUSEUM PERSONNEL

Some changes have taken place in the personnel of the Museum.

Mr. Frank M. Anderson, curator of the department of invertebrate paleontology was granted leave of absence May 1, 1914, to permit him to engage in certain economic work in South America in the interest of an oil company.

Mr. Bruce Martin, assistant curator of the department of invertebrate paleontology, resigned on May 1 to accompany Mr. Anderson to South America, and Dr. Roy E. Dickerson was appointed to the vacancy caused by Mr. Martin's resignation, effective August first.

Mr. Chas. Fuchs, for many years the assistant curator of entomology, died June 11, 1914. Mr. Fuchs had served the Academy long and faithfully. His skill as a preparator of entomological specimens was unsurpassed. His enthusiasm and his pleasant, unaffected disposition endeared him to all with whom he was associated. In his death the Academy suffers a real loss.

### ACCESSIONS TO THE MUSEUM

Although the Academy conducted no extensive field investigations during the year, the additions to the Museum have nevertheless been many and important. Most of these have been in the nature of donations by friends of the Academy. A detailed list will be found in an appendix to this report. Attention is called in the President's report to a few of the more important accessions.

### THE MUSEUM

As already stated, because of the failure of the concrete and brick contractors to comply with their contract, the completion of the new Museum building has been delayed several months. It is believed, however, that the difficulties will soon be adjusted, that construction work will be resumed within a short time, and that the building will be ready for occupancy in the near future.

In the meantime, it is proper to consider some of the problems which will confront us when we are actually in the new building.

With the completion of the new Museum building, the Academy will enter upon a new era. It will then have an opportunity to develop its Museum along what it regards as the most proper lines. The first important question that must be considered is that of policy. What shall be the scope of the Museum's work? What shall be its ideals and its aims? How can its ideals and aims be realized?

These questions are so vital that I feel that I should take this opportunity to touch briefly upon them.

Chiefly through the efforts of Mr. Loomis, assisted by President Grunsky and Judge Hittell, the property of the California Academy of Sciences was exempted from taxation by a constitutional amendment. That action by the people of the State placed an obligation on the Academy, an obligation to every person in the state. The Academy must do something for the people of San Francisco and the state in return for what the state has done for it.

When the Academy gets into the new building it will then be in a position to do many things; there will be many things

it will wish to do; there will be many things it must do; there will be many problems it must then meet. The time is opportune for consideration of some of those problems.

The first question to consider is the large and fundamental one as to the general policy of the Museum.

The character or type of museum which the Academy wishes to maintain must be determined. Along what lines shall its principal activities lie? How can it do the most good as a scientific, educational institution? .

The one thing that will impress one most in a study of eastern museums is their activity along educational lines, and the ways in which they are endeavoring to interest the public, and to be of service to the public.

It is apparent that the museums of the east are beginning to realize more and more that they owe a debt to the public and to those who have made their existence possible. Until recently most museums have done little or nothing in respect to general education. "They have been content to be merely vast depositories for collections of priceless value, either unseen or gazed upon in mute wonder by those who visited them."

In such museums the visitors "wander listlessly and aimlessly about the halls and galleries, with little appreciation and scarcely any understanding of the treasures that surround them."

But a great change has come about within the last few years. Now, the museum has come to regard itself, and to be regarded by the public, as an educational institution, working in cooperation with the public and private schools for the good of all the children who can be brought under its influence. It is now realized that a public museum, in order to justify its existence, must be of real service, not only to investigators, but to the general public, as well.

To meet the needs of the investigator, the museum must be an institution for research, an institution for the acquirement of knowledge and its diffusion among men. A museum furnishes facilities for research and the acquirement of knowledge through, and in proportion to the completeness of, its research collections, and the encouragement it gives to field and laboratory investigations. The knowledge acquired by

its investigators through field investigations and laboratory study of specimens is made known to the world chiefly through the medium of the museum's publications.

This important function of the museum has been admirably performed by the California Academy of Sciences. Its publications have always been of a high order of excellence, and through them the Academy is well and favorably known throughout the scientific world. This function of the museum must not be neglected; research must be encouraged in every proper way.

The second function of a public museum is that of usefulness to the public in an educational way. Not until recently has this function been realized or received much attention, but now it is the dominant and controlling thought in many of our greatest museums.

It is true that most museums, from the very beginning, have maintained considerable collections of natural history objects, and specimens in other groups, which the visitor might see; but, as Director Lucas of the American Museum of Natural History has so well said, "The visitor was greeted by row upon row of animals, most literally stuffed, arrayed in ranks and accompanied by labels whose principal mission was to convey to the public what to them is a most unimportant matter, the scientific names."

Shall our Museum be a "Haunt of the Muses", such as Ptolemy Soter founded at Alexandria in 300 B. C.? Yes, it should be that, but it must be much more than that. It should be not only a place "dedicated to the cultivation of learning" and frequented by men and women devoted to learning and the improvement of human knowledge, but it should also be a treasure-house of specimens of the animals, plants and other natural objects of the world, and of objects illustrative of the life and activities of the races of men.

Museums, in the modern sense of the word, had their origin in the effort to preserve and care for rare and curious objects which travelers brought home from distant parts of the world. Collecting of rare and strange objects was first raised to the dignity of a fine art in Italy. The Medici at Florence and the Estes in Modena were the first; they set the example which in time spread throughout Europe.



But the collectors of those days were rarely imbued with the scientific, or even educational spirit; their motives were largely selfish, or would be so regarded in our day. They were usually wealthy and cultivated amateurs who assembled and maintained collections for their own pleasure and glorification. It was not until 1753—just 100 years before the founding of the California Academy of Sciences—when the British Museum was established at Bloomsbury and the collections of Sir Hans Sloane acquired, that the idea of a public museum emerged. It was then realized, apparently for the first time, that a museum, to advance art and scientific knowledge, must be liberally endowed, or else fostered by the State. And it was not long ago that museums first began to realize that they have a double duty to perform.

The Museum of this Academy, speaking broadly, has two primary functions. In the first place, it must furnish materials and facilities for research, and men to carry on the research work. While its legitimate field is not limited by geographic boundaries or to particular subjects in the realm of science, it is particularly appropriate that it should concern itself with problems concerning the natural history, geology, and anthropology of the Pacific coast of the Americas and of the Pacific islands. The problems within these fields are many and tremendously important. Their study will result in many valuable contributions to human knowledge. The collections which would be made in connection with these investigations will add greatly to the Museum's treasures. Those that would be obtained from the islands of the Pacific would make it possible to build up here in San Francisco a great Polynesian Museum. San Francisco is the logical place for such a museum. It should be the ambition of the California Academy of Sciences and the people of California to build up such a museum. Such an undertaking should receive substantial encouragement.

And the research collections of the animals and plants, of the geology, paleontology, and the native races of western America and of the Pacific Ocean and its islands, should be comprehensive and ample for the investigator's use.

Then there is the educational obligation which the Academy owes to the public and the state. This obligation can be met

in a number of ways, a few of which may be briefly mentioned here. In the first place, the Academy must instal and maintain in its Museum objects and groups of objects that are educative in character; that will teach definite lessons; and they must be displayed in such manner as will enable the visitor readily to gain the knowledge which the exhibit is meant to impart. And right there is a vital point: the object must be displayed in a way which will enable the visitor to understand the lesson it is meant to teach. To be sure, the collections must be properly labelled and placed in good light, but that is not enough. The arrangement and the grouping must be considered. And there must be intelligent, sympathetic interpreters or guides whose appreciation of the lessons to be taught, and whose enthusiasm will become contagious as the exhibits are explained to the visitors. The visitors will thus get the most out of what they see. Among exhibits that can be made of the greatest popular interest and highest educational value are the large habitat groups of California animals to which reference has already been made. Added to these there should be seasonal groups of birds and other animals, in which the animals will be shown in natural surroundings as they appear at different seasons of the year. For example, there should be four seasonal groups of the birds of the vicinity of San Francisco, one showing the winter species under winter conditions, and one for each of the other seasons. Similar groups of ptarmigan, snowshoe rabbits, deer and other animals will be provided.

Then there is the Lowe collection of Indian baskets, pottery and other objects of Indian manufacture and use now ready to instal, a collection that has great educational value.

And still another now available is the Henry Hemphill conchological collection of marine, freshwater and land shells, especially rich in west coast species, and very valuable not only for exhibition purposes but also for research.

Then, in addition to the large habitat and ecological groups, the museum must contain small groups or family groups of small animals of special interest and educational value. These groups should be many in number because the lessons are many and important which can best be taught by them. And a well-appointed museum will make it possible for every child in

the city, or any child who can come to the museum, to see and study and understand these specimens.

It seems to me that the educational function of our museum is the thing we now should emphasize and make provision for. It has been too long neglected. There are various ways, in addition to the one already dwelt upon, through which this purpose of the museum can be realized. I may be permitted to mention a few of them:

A carefully thought-out method of cooperation with the public and private schools must be provided. In the preparation of exhibition material provision should be made for exhibits that will meet the needs of children of each of the school grades. There should be exhibits that even first and second grade children, as well as those of the higher grades, can understand, and which will teach them definite lessons. And there should be exhibits adapted to each of the eight grades and to the high school.

There should be maintained at the museum throughout the school year courses of lectures on natural history and related subjects, such as should form a part of the regular school curriculum. These lectures should be given daily. They would be adapted to the needs of the various grades. They should relate to subjects for which the museum possesses in its collections illustrative materials. The museum should also provide carefully selected stereopticon slides, moving pictures, transparencies, photographs, and other educational aids for use in its educational work.

The museum should begin as soon as possible to provide loan collections to send out to the schools. These should be small habitat groups and specimens of the smaller birds, mammals, reptiles, batrachians, fishes, insects, minerals, plants, and other natural objects which can be put up in portable cases of a form and size convenient for handling. It is believed this will prove to be one of the most effective methods of cooperation with the public schools.

Another way in which the museum can be of benefit to the schools is by encouraging the teachers in the schools to visit the museum and make use of its materials, and by encouraging its curators and others connected with the museum to give lectures before schools, teachers, and educational organizations

on subjects in which they are specialists. These lectures may be given either in the schools or at the museum, or wherever circumstances may require.

The museum must be a *public* museum. We have long had public schools designed to prepare our children for rational living and good citizenship. A little later public libraries came to be considered as a necessary part of the educational plant. If *public schools* and *public libraries*, why not *public museums*?

Every city, town and community in the land taxes itself heavily to support the public schools. Many do the same for public libraries. A few, a very few as yet, tax themselves to support public museums. But the time is not far distant, I verily believe, when the public museum will be recognized as an essential part of the educational equipment of every town and city.

Now, all this means money and men. A great museum can not be built up nor maintained without funds and men.

Provision must be made for the expenses of field work, of exploration and research. And the museum must have adequate funds and an adequate force of experts to prepare the habitat groups and the other exhibition material, the loan collections, the transparencies, the photographs and stereopticon slides; to care for the research and other collections; to do the research work; and to do the multitude of things which must be done in any live, growing, efficient museum.

Undoubtedly the best way to build up and maintain a great museum is by means of large general and specific endowments which yield definite annual incomes to be devoted to specific purposes. Among the endowments which the California Academy of Sciences should receive the following may be mentioned:

1. *An Endowment for Exploration and Research.*

This endowment should be in a sum of not less than \$2,500,000 that would yield an income of, say, \$100,000, to be devoted to exploration and investigation of the zoology, botany, geology, and anthropology of the Pacific coasts of the Americas and the islands of the Pacific. The need for this endowment is urgent, for the native races of these regions

and their works are passing, and the studies must be undertaken before it is too late.

A great Polynesian museum should be built up here in San Francisco. This is the logical place for such a museum. It should contain great research collections of the animals and plants and minerals of all the countries bordering on the Pacific, but there should also be well selected exhibits showing the natural and manufactured products of all these countries, displayed after the manner followed in the great commercial museums of the world. Such exhibits would serve to call the attention of men of business to the commercial products and possibilities of the various countries concerned, and would do much toward bringing the trade of those countries to San Francisco. The possibilities along this line can scarcely be overestimated.

## 2. *An Educational Extension Endowment.*

This endowment should be \$250,000 and yield an annual income of about \$10,000, to be used in the preparation of loan exhibits and collections to send out to the public and private schools; in the maintenance of courses of lectures at the museum and in the schools, on subjects adapted to the needs and understanding of the children of the different grades; in the preparation of stereopticon slides, photographs, transparencies, and moving pictures, relating to the various branches of elementary science which properly form parts of a well-balanced school curriculum; in short, to provide for co-operation between the museum and the public schools.

It is believed this is one of the most useful activities in which the museum can engage.

Recently Mr. N. W. Harris of Chicago gave to the Field Museum of Natural History a quarter of a million dollars as an endowment for this purpose. It is known as "The N. W. Harris Public School Extension of Field Museum of Natural History." It yields an annual income of \$12,000, all of which is devoted to cooperation with the public schools of Chicago. Cannot a similar fund be secured for similar work in California? Is there not some one who is interested in education who is able and willing to do as much for San Francisco?

### 3. *A Library Endowment.*

A great library of the natural and physical sciences should be built up here in San Francisco. A large endowment is necessary; but for the present, if an endowment of not less than \$200,000 can be secured the immediate needs would be fairly well met. The income from this fund, amounting to \$8,000 to \$10,000 would be used in the purchase of books, pamphlets and periodicals, for binding, and other expenses incident to building up and maintaining the library.

### 4. *Publication Fund.*

The publication fund of the Academy has never been adequate. It is very inadequate now. Papers of the highest scientific value have to be refused every year because of lack of funds for their publication. Because of the lack of funds the Academy has never been able to use the durable paper for the text and for the illustrations which the high value of its publications demands. Papers of the greatest value have been printed on paper that will probably not last fifty years. An endowment of \$100,000 would be of very great help in enabling the Academy to print its publications in proper form and to maintain its Proceedings at a high standard of excellence.

In addition to these large and urgently important needs of the Academy, there are many smaller special needs. Each of the departments in the Academy has, and will always have, need for funds for special investigations. There are, for example, special problems which the department of geology is interested in and which it would like to undertake to solve. And the same is equally true of the other departments, particularly of botany, herpetology, invertebrate paleontology, invertebrate zoology, ornithology, entomology, and mammalogy. There should be small endowments for each of these departments in order that each may be assured of a reasonable sum for field work every year.

President Grunsky has called attention to the Academy's immediate need of not less than a million dollars for completing the museum building in all its units as originally designed and as urgently needed. The west wing now nearing completion will be inadequate to house the collections that the Academy

already possesses, to say nothing of the space needed for the expected immediate rapid growth of the museum.

I have said nothing about the need of a great aquarium in this city in which may be shown the food and game fishes and the myriads of other fishes and other life of our rivers and lakes and of the sea. Such an aquarium is sure to come. Now is the opportune time seriously to consider its establishment. The Academy of Sciences stands ready to render any service it can in this matter.

I have mentioned a few of the things which the California Academy of Sciences ought to do and which it can do if it receives the support from the public which it should receive. There are many other scientific and educational activities in which it will doubtless engage in due time.

The total of the endowments and gifts needed by the Academy is big. But the problems are big, and the educational, scientific, and material benefits that will come to San Francisco and the entire Pacific coast will be of inestimable value.

Recently I compiled a statement showing the amounts given by public spirited citizens of the United States for educational and scientific aid and endowments as noted in the weekly journal, *Science*, for the period from March to December, 1914. The total is nearly \$77,000,000. Practically all of this enormous amount was given by men and women in the east and to museums and other educational institutions east of the Rocky Mountains.

No one believes that the men and women of wealth of the west coast of America are less appreciative of science and the educational value of the physical and biological sciences than are the people of the east. It is believed, that, when the matter is presented to them frankly and clearly, they will come forward and enable the Museum of the California Academy of Sciences to take rank with the greatest museums of the east.

There is one other matter to which I wish to call particular attention at this time. It is this: The new Museum should contain a Children's Room in which will be displayed natural history objects such as are particularly attractive and interesting to young children. There would be in this room brightly and curiously colored birds and butterflies, moths and beetles

and other insects; curious animals of other groups; attractive minerals, growing plants, and aquariums with interesting animal and plant life; colored transparencies of beautiful native flowers, all selected and arranged with reference to the telling of an interesting story, of teaching a definite lesson.

And there will be in this Children's Room a Children's Reading Room in which will be found a library of the interesting and reliable nature books and helps to nature study.

And there will be in charge of this Children's Room a well-educated, kindly, sympathetic woman, who knows animals and plants; who knows the specimens in the museum and the live things in the park about it; and who, above all, knows and loves children; a woman who can wisely direct the observation and the reading of the children so that they may correlate their reading with what they have seen in the museum or in the open, and thus *increase* rather than *stifle* their love of animate things, as our public schools almost invariably do. It will be arranged so that children of the different grades will come to this room at different hours, and receive the instruction and help adapted to their respective needs.

And all this will be done and done soon, I confidently believe. It will be done because it so evidently appeals to us all as being the *right thing to do*, the right sort of education and training to give our children. It will be done, because the beauty of it all, for the little children's sake, will appeal to someone who has prospered in this world; someone with a kindly heart, who loves children, and who wants to help them to become the men and women they should become; and some day that man will come forward and, out of his abundance, he will make it possible for the California Academy of Sciences to do this splendid work for the children of California, not only of today but for those of the years to come.



## APPENDIX TO DIRECTOR'S REPORT

## LIST OF ACCESSIONS TO THE MUSEUM, 1914

- Arnold Arboretum, Jamaica Plain, Mass.: A collection of 188 sheets of herbarium specimens, chiefly cultivated shrubs.
- Baker, Dr. Fred and Dr. Charlotte, San Diego, Cal.: Twelve hundred specimens from Japan all carefully identified by local botanists and labelled.
- Basel Museum, Basel, Switzerland: Three reptiles and batrachians from Canary Islands, 3 from Ceylon, one reptile from New Hebrides Islands, and one each from China and Algeria, 2 from Loyalty Islands and 4 from New Caledonia. Exchange.
- Beck, Mrs. R. H., Berryessa, Cal.: A small collection of insects from the west coast of South America. Purchase.
- Bekeart, Phil B., San Francisco: Medallion portrait of Col. Samuel Colt.
- Bliss, W. D., Truckee, Cal.: One flying squirrel.
- Bolton, Arthur L., California Academy of Sciences: Several specimens of plants from southeastern Arizona, among them two species that appear to be new.
- Brimley, C. S., Raleigh, N. C.: Sixteen batrachians from North Carolina, one from Alabama, two from the Bahamas, 7 reptiles and batrachians from Florida, 9 from Mexico and 10 from Panama, and 6 reptiles from Michigan. Exchange.
- British Museum, London: One reptile each from Senagambia, Gold Coast of Africa, and South America. Exchange.
- Brizini, Lieut., Manila, P. I.: One reptile from Philippine Islands.
- Carlson, John I., California Academy of Sciences: A small collection of insects from southern California.
- Carlson, John I., California Academy of Sciences: Sixty-nine specimens of reptiles and batrachians from Arizona and 36 from California.
- Carlson, John I., California Academy of Sciences: A collection of 94 sheets of herbarium specimens from Tucson and Agua Caliente, Arizona, and from Santa Catalina Island, California.
- Coker, Dr. Robert E., U. S. Biological Station, Fairport, Iowa: A collection of 423 shells representing 116 species of freshwater mussels (*Unionidæ*), chiefly from the Mississippi Valley.
- Coombes, Mrs. A. L., San Francisco: Twenty-four specimens of plants from southern Oregon.
- Davidson, Thomas, San Francisco: A large collection of minerals formerly belonging to the late Professor George Davidson.
- Dickerson, Dr. Roy E., California Academy of Sciences: A collection of about 40 species of fossils from the Eocene of Marysville Buttes.
- Dudley Herbarium, Stanford University, Cal.: A collection of 178 sheets of plants, chiefly Californian.
- Duncan, Carl B., Fresno, Cal.: Eight reptiles and batrachians from Fresno, Cal.
- Duncan, Carl B., Fresno, Cal.: One bat.

- Eastwood, Miss Alice, California Academy of Sciences: About 400 specimens of plants representing 96 additions to the herbarium with many duplicates, from Byron Springs and Antioch, Cal.; 500 plants with 110 additions, from the lower San Joaquin Valley; 112 from Mt. Rainier; 23 from Steilacoom, Wash.; 9 from Portland, Ore.; about 8000 specimens representing 1013 additions resulting from the Eastwood Yukon-Alaska expedition financed by Professor C. S. Sargent, head of the Arnold Arboretum; and many specimens of exotic plants from the region around San Francisco.
- Edmonds, W. O., Upper Lake, Cal.: Skull of a Kodiak bear.
- Ehrhorn, Adolph, San Francisco: A rawhide trunk from Peru, S. A.
- Evermann, Dr. Barton W., California Academy of Sciences: Nine reptiles and batrachians from Ventura and Kern counties, Cal.
- Evermann, Dr. Barton W., California Academy of Sciences: Skull of a chipmunk, *Eutamias merriami*, taken from a rattlesnake (*Crotalus oregonus*) in the Yosemite Valley.
- Evermann, Dr. Barton W., California Academy of Sciences: Thirty sheets of herbarium specimens from Ventura and Kern counties, California.
- Evermann, Dr. Barton W., California Academy of Sciences: A collection of Lower Miocene fossils from Ventura County, Cal.
- Fitzhugh, Hon. Wm. M., San Francisco: The Lowe collection of Indian baskets, pottery, blankets, and miscellaneous objects of Indian manufacture and use. An indefinite loan.
- Fuchs, Charles, California Academy of Sciences: Seven reptiles and batrachians, from Alameda and Napa counties, Cal.
- Gifford, E. W., Affiliated Colleges, San Francisco: One snake from Santa Clara County, Cal.
- Green, Chas. E., San Francisco: A Beck microscope, with numerous objectives and accessories.
- Greene, Dr. Edward L., Washington, D. C.: Fifty specimens of western plants, including some duplicates of his types.
- Henry, Professor J. K., Vancouver, B. C.: A collection of fifty plants from the vicinity of Vancouver.
- Henshaw, H. W., Biological Survey, Washington, D. C.: A collection of 278 specimens representing 28 genera and 75 species of ferns chiefly from Massachusetts and the vicinity of Washington, D. C.
- Hosmer, Mrs. Charlotte, Oakland, Cal.: The Henry Hemphill collection of marine, freshwater and land shells, embracing more than 60,000 specimens representing more than 12,000 species.
- Kellers, Dr. H. D., U. S. Navy: A collection of 56 sheets of herbarium specimens from St. Paul Island, Bering Sea.
- Kusche, J. Aug., Eldridge, Cal.: Twenty-three specimens of reptiles and batrachians, from Los Angeles County, Cal.
- Lockwood, A. D., San Francisco: Suit of Chinese armor.
- Mailliard, John W., San Francisco: A collection of 34 mounted specimens representing 24 species of winter birds of Marin County, Cal.
- Mailliard, Joseph, San Francisco: A ball of crude rubber from Peru, S. A.

- Martin, Bruce, Lorica, Colombia, S. A.: A small collection of insects, mostly beetles, from Colombia, S. A.
- Martin, Bruce, Lorica, Colombia, S. A.: Several hundred specimens representing about 200 species of fossils from the Tejon of California.
- Merrill, E. D., Philippine Bureau of Science, Manila, P. I.: Three hundred specimens of Philippine plants.
- Michigan, University of, Ann Arbor, Mich.: Eight reptiles from Michigan and two batrachians from Illinois. Exchange.
- Museum of Comparative Zoology, Cambridge, Mass.: Thirty-one reptiles and batrachians from West Africa, 4 from Ecuador, 150 from the West Indies, 3 batrachians from East Africa, 22 from Florida, 10 from Massachusetts, 36 from Chile, 2 reptiles from North Africa, one from Ceylon, 4 from Brazil, and 5 from Panama. Exchange.
- National Herbarium, Washington, D. C.: Seventy specimens of plants from the Mississippi Valley, a duplicate set of the Eggert collection.
- Newell, Mrs. Gwendolan, San Francisco: A collection of 150 sheets of herbarium specimens from Los Gatos, Santa Barbara, and Fort Bragg, Cal.
- Percy, Earl N., Standard Oil Co., San Francisco: Two hundred feet of moving picture film showing California Valley elk.
- Phelps, Mrs. Kate Eastwood, Denver, Colo.: A collection of 90 sheets of herbarium specimens from Silver Lake, near Boulder, Colorado.
- Ray, Milton S., San Francisco: One reptile from Napa Co., Cal.
- Rixford, G. P., San Francisco: Thirty-five specimens of plants, chiefly rare exotics cultivated in California.
- Rothschild, Hon. Walter, Tring, England: One tortoise shell from Madagascar, and seven casts of Galapagos and Madagascar gigantic tortoises. Exchange.
- Rowley, John, California Academy of Sciences: A collection of 76 mammal skins chiefly from Kern County, Cal.
- Rowley, John, California Academy of Sciences: Seventeen skins of birds from Kern County, Cal.
- Sargeant, Jr. W. W., San Francisco: Two reptiles from San Francisco, Cal.
- Slevin, J. R., California Academy of Sciences: Five batrachians from Washington, and 138 reptiles and batrachians from Kern and San Francisco counties, Cal.
- Slevin, J. R., California Academy of Sciences: A small series of insects from Washington.
- Smith, L. E., Sisson, Cal.: Eight hundred specimens of plants representing 186 additions to the herbarium, the rest being duplicates to be used in exchange. These were collected in northern California and chiefly in the upper Sacramento valley.
- Tevis, Lansing K., San Francisco: Two specimens of a Javanese peacock.
- Tracy, Mrs. William, Buttonwillow, Cal.: Two ostrich eggs.
- Van Denburgh, Dr. John, California Academy of Sciences: One reptile from Santa Clara County, Cal.

- Van Dyke, Dr. Edwin C., California Academy of Sciences: Forty-six batrachians from Washington; 4 reptiles and batrachians from Oregon.
- Van Dyke, Dr. Edwin C., California Academy of Sciences: A considerable collection of miscellaneous insects from Washington, Oregon and California.
- Wilkens, Mrs. J. E., San Francisco: Two reptiles from San Francisco.

## LIST OF DONATIONS TO THE LIBRARY, 1914

- Baker, Dr. Fred, San Diego, Cal.: Eight pamphlets.
- Berry, S. Stillman, Redlands, Cal.: Twenty-two pamphlets.
- Cobb, W. Bruce: One volume.
- Crocker, Wm. H., San Francisco: Two volumes, Birds of New York.
- Eimbeck, Wm., through Capt. Ferdinand Westdahl, San Francisco: A miscellaneous collection of more than 200 books and pamphlets.
- Evermann, Dr. Barton W., San Francisco: A complete bound set (13 volumes) Proceedings of the Washington Academy of Sciences, and a copy of American Food and Game Fishes.
- Farlow, Prof. W. G., Cambridge, Mass.: About 40 early numbers of the Proceedings of the California Academy of Sciences.
- Gray Herbarium, Harvard University: One hundred and eighty pamphlets including many papers by Professor Asa Gray and Professor Sereno Watson.
- Green, C. E., San Francisco: Four portraits.
- Holmes, Prof. S. J., Berkeley, Cal.: Three pamphlets.
- Jones, R. L.: Life of J. Clancy Jones, 2 volumes.
- Kahn, Hon. Julius, San Francisco: The Laws of Alaska.
- Loomis, Leverett Mills, San Francisco: One book and 53 pamphlets.
- Mailliard, Joseph, San Francisco: The Native British Ferns, and 30 pamphlets.
- Manson, Dr. Marsden, Bellota, Cal.: One pamphlet.
- Martin, Bruce, Lorica, Colombia, S. A.: One volume.
- Meinecke, Dr. E. P., San Francisco: One pamphlet.
- Mexico, National Museum of: Two volumes.
- Mills College, Margaret Carnegie Library of, Mills College, Cal.: One volume.
- National Museum, Washington, D. C.: Five pamphlets, Contributions to the National Herbarium.
- Royal Botanical Gardens, Kew, England: Nine bulletins.
- Schaller, Dr. W. T., U. S. Geological Survey, Washington, D. C.: Two mineralogical papers.
- Smith, Prof. J. Perrin, Stanford University, Cal.: Four pamphlets.
- Thompson, Dr. J. C., U. S. Navy: Three pamphlets.
- Torrey Botanical Club, New York City: Twelve copies of Torreya.
- Van Denburgh, Dr. John, San Francisco: Two pamphlets.
- Wilson, Guy W., New Brunswick, N. J.: Seven pamphlets.
- Wistar Institute: Thirty-one numbers of the Journal of Morphology.
- Zoological Society of New York, New York City: Seven pamphlets.



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**FAUNA OF THE TYPE TEJON: ITS RELATION TO  
THE COWLITZ PHASE OF THE TEJON  
GROUP OF WASHINGTON**

BY  
**ROY E. DICKERSON**  
*Assistant Curator, Department of Invertebrate Paleontology*

**CONTENTS**

	PAGE
INTRODUCTION . . . . .	35
HISTORICAL . . . . .	35
TEJON GROUP AT TYPE LOCALITY	
<i>Stratigraphy</i> . . . . .	39
<i>Fauna</i> . . . . .	39
COWLITZ PHASE OF TEJON GROUP	
<i>Stratigraphy</i> . . . . .	47
<i>Fauna</i> . . . . .	49
COMPARISON OF FAUNAS . . . . .	50
SUMMARY . . . . .	51
DESCRIPTIONS OF SPECIES	
PELECYPODA	
<i>Leda uvasana, new species</i> . . . . .	51
<i>Leda vaderensis, new species</i> . . . . .	52
<i>Glycimeris ruckmani, new species</i> . . . . .	52
<i>Moretix tejonensis, new name</i> . . . . .	53
<i>Macrocallista vaderensis, new species</i> . . . . .	54
<i>Macrocallista (?) andersoni, new species</i> . . . . .	54
<i>Tellina howardi, new species</i> . . . . .	55
<i>Semele diaboli, new species</i> . . . . .	55
<i>Corbula harrisi, new species</i> . . . . .	56
<i>Corbula uvasana, new species</i> . . . . .	56

June 15, 1915.

## GASTROPODA

<i>Neverita weaveri</i> , new species . . . . .	57
<i>Lunatia cowlitzensis</i> , new species . . . . .	57
<i>Turritella uvasana bicarnata</i> , new variety . . . . .	58
<i>Turritella uvasana tricarnata</i> , new variety . . . . .	58
<i>Nerita cowlitzensis</i> , new species . . . . .	58
<i>Neritina martini</i> , new species . . . . .	59
<i>Rimella elongata</i> Weaver . . . . .	59
<i>Cypraea mathewsonii</i> Gabb . . . . .	60
<i>Melania packardii</i> , new species . . . . .	60
<i>Melania vaderensis</i> , new species . . . . .	60
<i>Ficopsis remondii</i> Gabb, <i>Ficopsis hornii</i> Gabb, <i>Ficopsis cooperi</i> Gabb, <i>Ficopsis cowlitzensis</i> Weaver . . . . .	61
<i>Pseudoliva inornata</i> , new species . . . . .	62
<i>Pseudoliva tejonensis</i> , new species . . . . .	63
<i>Triforis washingtoniana</i> , new species . . . . .	63
<i>Nyctilochus keui</i> , new species . . . . .	64
<i>Bursa washingtoniana</i> (Weaver) . . . . .	64
<i>Cantharus perrini</i> , new species . . . . .	65
<i>Chrysodomus ruckmani</i> , new species . . . . .	65
<i>Siphonalia bicarinata</i> , new species . . . . .	66
<i>Molopophorus tejonensis</i> , new species . . . . .	66
<i>Hemifusus sopenahensis</i> Weaver . . . . .	67
<i>Hemifusus volutaformis</i> , new species . . . . .	67
<i>Exilia waringi</i> , new species . . . . .	68
<i>Whitneya ficus</i> Gabb . . . . .	69
<i>Murex packardii</i> , new species . . . . .	69
<i>Urosalpinx hannibali</i> , new species . . . . .	69
<i>Surcula cohni</i> , new species . . . . .	70
<i>Surcula</i> ( <i>Surculites</i> ) <i>sinuata</i> Gabb . . . . .	70
<i>Drillia ornata</i> , new species . . . . .	71
<i>Turris pulchra</i> , new species . . . . .	71
<i>Surcula uvasana</i> , new species . . . . .	71
<i>Surcula io</i> (Gabb) . . . . .	72
<i>Fusus washingtoniana</i> Weaver . . . . .	72
<i>Fusus willisi</i> , new species . . . . .	73
<i>Fasciolaria buwaldana</i> , new species . . . . .	73
<i>Fasciolaria sinuata</i> Gabb . . . . .	74
<i>Conus californiana</i> (Conrad) . . . . .	74
<i>Conus weaveri</i> , new species . . . . .	74
<i>Mitra uvasana</i> , new species . . . . .	75
<i>Mitra slevini</i> , new species . . . . .	75
<i>Voluta martini</i> , new species . . . . .	76
<i>Voluta</i> , species . . . . .	76

## INTRODUCTION.

The Tejon group of California has a very characteristic fauna and, partially on this account, strata of this group have been recognized easily in many places throughout this state and in the neighboring states of Oregon and Washington.

An examination of the fauna of the type locality of the Tejon on Cañada de las Uvas has revealed many new species and many species described from other localities. The fauna as a whole does not represent the entire assemblage of the forms of the Tejon group, but only one zone appears to be present. The discovery in the type Tejon of several new species which had been described from the Washington Eocene has led to this comparison of the Washington Eocene fauna with that of the type Tejon.

This paper deals with the faunal relations of the Cowlitz phase of the Tejon group of Washington and that of the type locality of the Tejon in California. In brief, the conclusions of this comparative study are that the Cowlitz phase is in reality identical with the faunal assemblage from the typical Tejon at Cañada de las Uvas, and that both faunas belong to a middle zone of the Tejon group which will be called the *Rimella simplex* Zone.

## HISTORICAL.

The first recognition of Eocene on the Pacific Coast was made by Conrad,<sup>1</sup> and was based upon the fossils contained in a boulder sent by Blake from Cañada de las Uvas.

Conrad described the following new species: *Cardium lineatum*, *Dosinia alta*, *Meretrix uvasana*, *Meretrix californiana*, *Crassatella uvasana*, *Mytilus humerus*, *Volutilithes californiana*, *Busycon* (?) *blakei*=(*Perissolax blakei*), *Clavatula* (?) *californica*=(*Fusus californicus*), *Natica alveata*=(*Amauropsis alveata*), and he identified *Venericardia planicosta*, *Natica ætites* (?), *Natica gibbosa* and *Crassatella alta* of the Claiborne Eocene.

<sup>1</sup> Pacific Railroad Reports, App. to Prelim. Geol. Rept. of W. P. Blake, Palaeontology, pp. 5-20, 1855. Reprinted in Pacific Railroad Reports, vol. 5, part 2, pp. 317-329, 1857.



Concerning this occurrence Conrad states that "The Eocene period is unequivocally represented, by the beautifully perfect shells from the Cañada de las Uvas, which, though not found in situ, are evidently derived from strata occurring on the Pacific slope of the Sierra Nevada. This is very remarkable, inasmuch as three species correspond with forms of Claiborne, Alabama, and seem to indicate a connection of the Atlantic and Pacific oceans during the Eocene period. The vast distance between the two localities will account for the general distinction of species, and it was indeed, an unexpected result to find any identical. If I had imagined any eastern species to occur in California, it would have been the very one which does occur, and apparently in abundance, that 'finger post' of the Eocene, *Cardita planicosta*, a fossil of the Paris Basin, and also abundant in Maryland, Virginia and Alabama. This species originated and perished in the Eocene period, and is so widely distributed that it may be regarded as the most characteristic fossil of its era. As the boulder from which these shells were derived was quite small, and yet furnished thirteen species, when it shall be investigated in situ, doubtless a great many other forms will be obtained, and very likely some with which we are already familiar in eastern localities. Although the rock is a very hard sandstone, the shells may be exposed in great perfection by careful management, and we look forward with great interest to their further development, and to the discovery of the rock in situ."

Gabb<sup>2</sup> in 1864 described many species which Captain Horn collected from the vicinity of Cañada de las Uvas and referred the strata yielding this fauna to Division B of the Cretaceous. Whitney<sup>3</sup> in the next volume described the type locality of the Tejon-Eocene as follows:

"The Tejon group . . . the division B of Palaeontology, vol. 1, is peculiar to California. It is found most extensively developed in the vicinity of Fort Tejon and about Martinez. From the latter locality it forms an almost continuous belt in the Coast Ranges to Marshs', 15 miles east of Mount Diablo, where it sinks under the San Joaquin plain. It was also dis-

<sup>2</sup>Gabb, Wm., *Geology of California, Palaeontology*, vol. 1, 1864.

<sup>3</sup>Whitney, J. D., *Geology of California, Palaeontology*, vol. 2, p. 19 of preface, 1869.

covered by the different members of the survey at various points on the eastern face of the same range as far south as New Idria, and in the summer of 1866 by Mr. Gabb in Mendocino County, near Round Valley, the latter locality being the most northern point at which it is as yet known. . . . .”

“This group contains a large and highly characteristic series of fossils, the larger part peculiar to itself, while a considerable percentage is found extending below into the next group (Martinez)”.

For several years the controversy concerning the age of the Tejon was waged. Conrad,<sup>4</sup> Gabb,<sup>5</sup> Whitney,<sup>6</sup> Cooper,<sup>7</sup> Marcou,<sup>8</sup> Heilprin,<sup>9</sup> Newberry,<sup>10</sup> White,<sup>11</sup> Becker,<sup>12</sup> Clark,<sup>13</sup> Harris,<sup>14</sup> Diller,<sup>15</sup> all contributed to this question. The cretaceous ghost of the Tejon was finally laid by Stanton<sup>16</sup> and Merriam.<sup>17</sup> Most of the papers cited deal with the Tejon in general, and direct references to the type locality are few in number.

<sup>4</sup> Conrad, T. A., “Observations on Certain Eocene Fossils described as Cretaceous, by W. M. Gabb in his Report published in “Palaeontology of California”, *Am. Jour. Conchol.*, vol. 1, pp. 362-365, 1865; “Further Observations on Mr. Gabb’s Palaeontology of California”, *Am. Jour. Conchol.*, vol. 2, pp. 97-100, 1866; “Check list of Invertebrate Fossils of North America, Eocene and Oligocene”, p. 37, *Smithsonian Misc. Coll. No. 200*, 1866; *Am. Jour. Sci.*, 2nd series, vol. 44, pp. 376-377, 1867.

<sup>5</sup> Gabb, W. M., Reply to Mr. Conrad’s Criticism on Mr. Gabb’s Report on the Palaeontology of California”, *Am. Jour. Conchol.* vol. 2, pp. 87-92, 1866; *Amer. Jour. Sci.*, 2nd series, vol. 44, pp. 226-229, 1867; On the Subdivisions of the Cretaceous Formation in California, *Cal. Acad. Sci. Proc.*, 1st series, vol. 3, pp. 301-306, 1867; *Geol. Surv. California, Palaeontology*, vol. 2, 1869.

<sup>6</sup> Whitney, J. D., *Geol. Surv. California, Palaeontology*, vol. 2, 1869.

<sup>7</sup> Cooper, J. G., “The Eocene Epoch in California—Are there really no Eocene strata?”, *Cal. Acad. Sci. Proc.*, 1st series, vol. 5, pp. 419-421, 1874.

<sup>8</sup> Marcou, J., *Am. Rept. Geog. Surv. West 100° Merid.*, pp. 167-169, 1876; “Note sur la geologie de la Californie”, *Bull. Soc. geol. France*, 3rd series, vol. 11, pp. 407-435, 1883.

<sup>9</sup> Heilprin, A., “On the Occurrence of Ammonites in Deposits of Tertiary Age”, *Proc. Acad. Nat. Sci. Phila.*, vol. 34, p. 94, 1882; “On the Age of the Tejon Rocks of California, and the Occurrence of Ammonitic Remains in Tertiary Deposits”, *Proc. Acad. Nat. Sci., Phila.*, vol. 34, pp. 196-214, 1882.

<sup>10</sup> Newberry, J. S., “On Supposed Tertiary Ammonites”, *Proc. Acad. Nat. Sci. Phila.*, vol. 34, pp. 194-195, 1882.

<sup>11</sup> White, C. A., On Marine Eocene, Fresh Water Miocene and other fossil Mollusca of Western North America, *Bull. 18, U. S. Geol. Surv.*, pp. 7-9, 1885.

<sup>12</sup> Becker, G. F., “Notes on the Stratigraphy of California”, *Bull. 19, U. S. Geol. Surv.*, pp. 1-25, 1885.

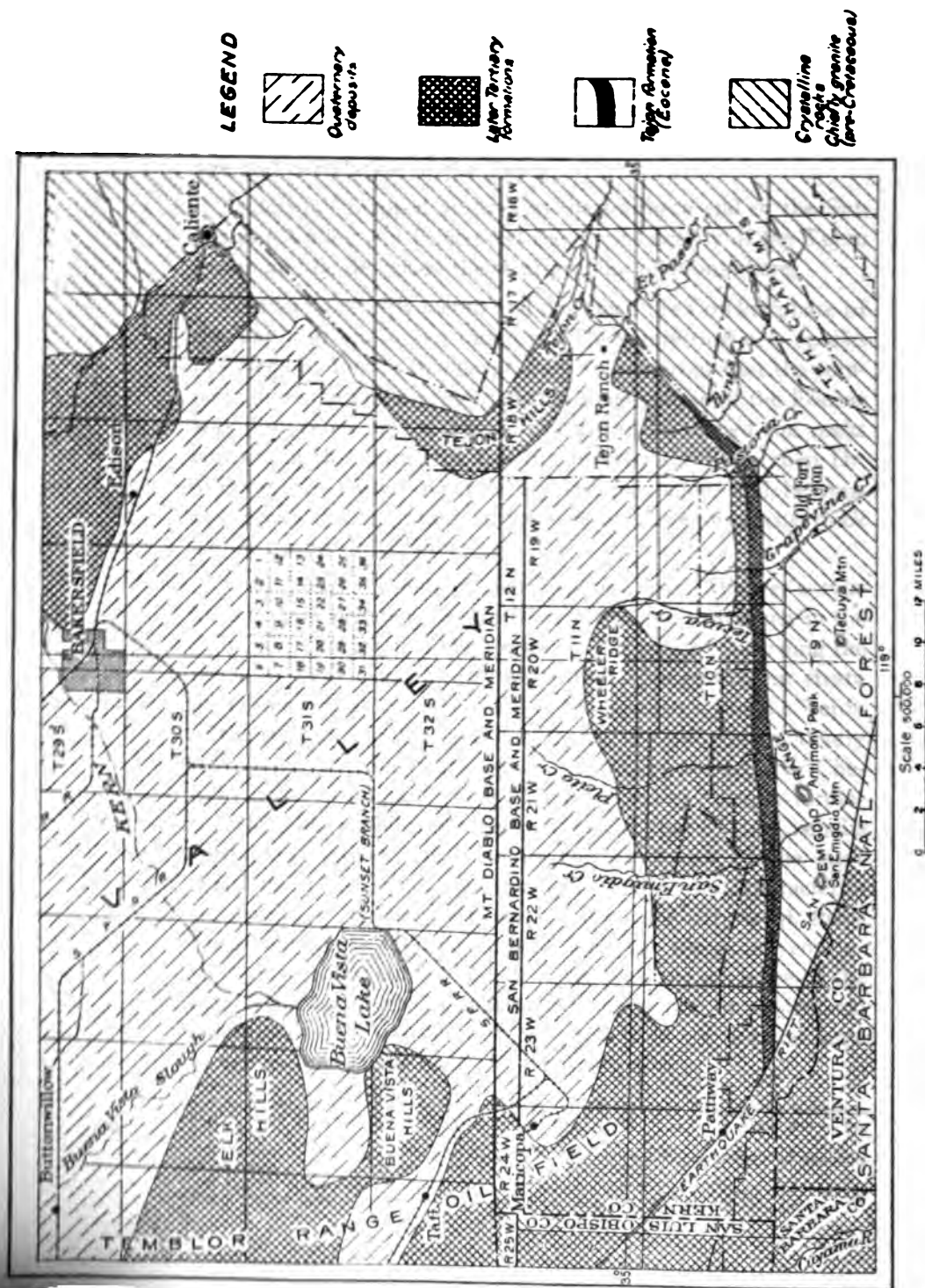
<sup>13</sup> Clark, Wm., “Correlation Essays, Eocene”, *Bull. 83, U. S. Geol. Surv.*, pp. 95-110, 1891.

<sup>14</sup> Harris, G. D., “Correlation of the Tejon with Eocene Stages of the Gulf Slope”, *Science*, vol. 22, p. 97, 1893.

<sup>15</sup> Diller, J. S., *Bull. Geol. Soc. Am.*, vol. 4, pp. 218-220, 1893.

<sup>16</sup> Stanton, T. W., “The Faunal Relations of the Eocene and Upper Cretaceous on the Pacific Coast”, 17th Annual Report, *U. S. Geol. Surv.*, pp. 1011-1059, 1896.

<sup>17</sup> Merriam, J. C., “The Geological Relations of the Martinez Group of California at the Typical Locality”, *Jour. Geol.*, vol. 5, pp. 767-775, 1897.



Text Figure 1.—Map of Southern End of San Joaquin Valley showing type locality of Tejon group on Grapevine Creek (After Robert Anderson).

## TEJON GROUP AT TYPE LOCALITY.

## STRATIGRAPHY.

The Tejon group at the type locality is a portion of an east-west strip which extends from Tunis Creek on the north flanks of the Tehachapi Mountains to a point about three miles southeast of Pattiway where it is cut off by the San Andreas Fault. The map (see Text Figure 1) which is adapted from the "Preliminary Report on the Geology and Possible Oil Resources of the South End of the San Joaquin Valley, Cal." by Robert Anderson shows the general distribution of the Tejon very satisfactorily.

The Tejon strata in the vicinity of Grapevine Creek rest upon a Basement Complex consisting of granitic rocks and associated schists. The beds in general have a steep north dip of 75° to 85°, but are disturbed in places so that the dip is reversed. The basal member, about 250 to 300 feet in thickness, consists of a very coarse conglomerate derived from the granitic rocks of the Basement Complex. This member is overlain by about 1000 to 1200 feet of thin bedded, brown sandstone with subordinate strata of dark gray, clay shale containing limestone nodules. The sandstone is, in places, conglomeritic and in one locality the dark gray pebbles of shale yielded a small *Pecten*. The occurrence of this *Pecten* suggests the deposition of earlier deposits which were completely removed during Eocene time. The uppermost strata—about 1200 feet in thickness—consist chiefly of light tan sandstone with subordinate strata of shale and brown sandstone. The total thickness of the Tejon group along Grapevine Creek (Cañada de las Uvas) is about 2500 feet. The Tejon is overlain by volcanic ash of Oligocene or Miocene age on the west side of Grapevine Creek. Mr. Bruce Martin states that the uppermost Tejon beds in Live Oak Creek are covered by a lava flow.

## FAUNA

The middle portion of Tejon group in the vicinity of Grapevine Creek is particularly rich in upper Eocene species. The basal beds yielded a small fauna (Cal. Acad. Sci. locality 246) which consists of *Spondylus carlosensis*, *Barbatia*, sp., *Meretrix*, sp. and *Ostrea*, sp.

Beds about 300 feet above the base (Univ. of Cal. locality 458) yielded an excellent fauna. This fauna, however, does not differ essentially from that of the beds higher in the section. The faunas from several other localities which are listed below do not differ materially from one another but all appear to represent one phase only. This faunal unity is in consonance with the sedimentary record as Anderson<sup>21</sup> described it. "The beds throughout possess a marked similarity and give every appearance of representing a period of continuous deposition in one basin. They are therefore to be regarded as making up a formation, and not a larger division of the geologic column."

The writer is in complete agreement with Anderson's views as expressed here in relation to the type Tejon. However, beds both higher and lower than the Eocene of Cañada de las Uvas occur in other parts of the state, notably in the vicinity of Mount Diablo, along Cantua Creek, Coalinga Quadrangle and at the Marysville Buttes. Owing to these facts the expression—Tejon group—is fully warranted upon both stratigraphic and faunal grounds.

The fauna of the type Tejon corresponds with zone 2<sup>22</sup> of the Mt. Diablo section. This zone will be called henceforth, the *Rimella simplex* Zone, after a characteristic fossil in its fauna. It is characterized by the abundance of *Turritella uvasana*, *Rimella simplex*, *Meretrix ovalis*, *Macrocallista conradiana*, *Meretrix hornii*, and by the absence of the *Turbinolia pussilanima*, n. sp. and other species of Zone 1 of the Mount Diablo section, and *Siphonalia sutterensis*, *Venericardia planicosta merriami* and other members of the *Siphonalia sutterensis* fauna. The greatest extent of the Tejon Sea in California at this stage is represented graphically in the figure on the opposite page (see Text Figure 2). The fauna obtained from the type locality of the Tejon group is given below.

<sup>21</sup> Anderson, Robert, Preliminary Report on the Geology and Possible Oil Resources of the South End of the San Joaquin Valley, Cal. Bull. 471, U. S. Geol. Surv., p. 118, 1912.

<sup>22</sup> Dickerson, R. E. Note on the Faunal Zones of the Tejon Group, Univ. Calif. Publ. Bull. Dept. Geol., vol. 8, pp. 17-25, 1914.



TEXT FIGURE 2—Map of California showing probable extent of the Tejon Sea during the deposition of rocks which have yielded the *Rimella simplex* fauna. 1, Tejon at Lower Lake; 2, Tejon at Benicia; 3, Tejon vicinity of Mount Diablo; 4, Tejon of Coalinga region; 5, Tejon of the Santa Clara Valley of the South; 6, Tejon of the Santa Ana Mountains; 7, Tejon of San Diego; 8, Tejon in Round Valley, Mendocino County; 9, Type Locality of the Tejon group. This stage is the only one which is represented at San Diego and the Santa Ana Mountains.



[illegible]





LIST OF CALIFORNIA ACADEMY OF SCIENCES  
LOCALITIES, VICINITY OF GRAPEVINE CREEK.

244. Tejon Quadrangle, Kern County, California, Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., Bruce Martin.

245. Tejon Quadrangle, Kern County, California. Tejon group. Along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about 35 miles south of Bakersfield, California. The fossils were found in strata at an elevation of about 2000 feet, near the middle of the Tejon section. Coll., Bruce Martin.

246. Tejon Quadrangle, Kern County, California. Tejon group. In hard conglomeritic sandstone near the top of a small hill about 300 yards west of Grapevine Canyon and about one-half of a mile south of its mouth. Elevation 2800 feet. This locality is near the base of the Tejon. Coll., Bruce Martin.

DESCRIPTIONS OF UNIVERSITY OF CALIFORNIA  
LOCALITIES IN THE VICINITY OF CAÑADA  
DE LAS UVAS (GRAPEVINE CREEK).

451. Tejon Quadrangle. Tejon group. West side of Grapevine Creek, elevation 2500 feet, T. 10 N., R. 19 W., Mt. S. B. B. L. and M., N. of center of S. W.  $\frac{1}{4}$ , Sec. 20;  $\frac{1}{4}$  mile north of Basement Complex-Tejon contact. Coll., R. E. Dickerson.

452. Tejon Quadrangle. Tejon group. On road in Grapevine Creek; S. W.  $\frac{1}{4}$  of S. E.  $\frac{1}{4}$  of Sec. 20, T. 10 N., R. 19 W., Mt. S. B., B. L. and M., elevation, 2000 feet. R. E. D. 530. Coll., R. E. Dickerson.

453. Tejon Quadrangle. Tejon group. Grapevine Creek; T. 10 N., R. 19 W., Mt. S. B., B. L. and M., S. W.  $\frac{1}{4}$ , Sec. 29. 300 feet N. of Basement Complex-Tejon Contact; R. E. D. 531. Coll., R. E. Dickerson.

454. Mt. Pinos Quadrangle. Tejon group. On Tejon-Miocene contact,  $\frac{1}{4}$  mile E. of Salt Creek and 100 yards S. of

Salt Creek on ridge; T. 10 N., R. 20 W., Sec. 33, Mt. S. B., B. L., and M. on north center section line. R. E. D. 532; Avicula Bed. Colls., Roy Cohn and R. E. Dickerson.

455. Tejon Quadrangle. Tejon group. On Tecuya Creek about  $1\frac{3}{4}$  miles from mouth of canon; R. E. D. 533. Colls., Roy Cohn and R. E. Dickerson.

456. Tejon Quadrangle. Tejon group. On Tecuya Creek. 200 feet S. of red agglomerate of Miocene, near top of the Tejon Group. R. E. D. 534. Colls., Roy Cohn and R. E. Dickerson.

457. Tejon Quadrangle. Tejon group. On west side of Grapevine Canyon; elevation 2100 feet; 5 miles S.  $8^{\circ}$  W. of 1085 feet B. M.; 50 to 100 feet above Basement Complex-Tejon Contact. Coll., R. E. Dickerson.

458. Tejon Quadrangle. Tejon group. West side of Grapevine Creek, elevation 2050 feet; about  $4\frac{1}{2}$  miles S.  $6^{\circ}$  W. of 1085 B. M.; about 400 feet (stratigraphic) above Basement Complex-Tejon contact. R. E. D. 536. Coll., R. E. Dickerson.

459. Tejon Quadrangle. Tejon group.  $4\frac{1}{4}$  miles S.  $9^{\circ}$  W. of 1085 B. M., on west side of Grapevine Creek, elevation 2000 to 2100 feet. R. E. D. 537. This locality is near top of section about 1800 feet (stratigraphic) above base. Coll., R. E. Dickerson.

460. Tejon Quadrangle. Tejon group. 4 miles S.  $10^{\circ}$  W. of 1085 B. M., near top of Tejon Group; R. E. D. 538. Coll., R. E. Dickerson.

461. Tejon Quadrangle. Tejon group.  $4\frac{1}{8}$  miles S.  $15^{\circ}$  W. of 1085 B. M. at Tejon-Miocene Contact. (*Schizaster lecontei* Merriam) R. E. D. 539. Coll., R. E. Dickerson.

462. Mt. Pinos Quadrangle. Tejon group. On Salt Creek. S. E.  $\frac{1}{4}$  of N. W.  $\frac{1}{4}$ , Sec. 32, T. 10 N., R. 20 W., Mt. S. B., B. L. and M., on north side of Canyon, a branch of Salt Creek, 100 feet from bottom. R. E. D. 540. Coll., R. E. Dickerson.

463. Mt. Pinos Quadrangle. Tejon group. Salt Creek. S. E.  $\frac{1}{4}$  of N. W.  $\frac{1}{4}$  of Sec. 32, T. 10 N., R. 20 W., Mt. S. B., B. L. and M. R. E. D. 541. Colls., B. Parsons and R. E. Dickerson.

464. Mt. Pinos Quadrangle. Tejon group. Vicinity of Salt Creek. S. E.  $\frac{1}{4}$  of N. W.  $\frac{1}{4}$  of Sec. 32, T. 10 N., R. 20

W., Mt. S. B., B. L. and M. on north side of a branch of Salt Creek 150 feet above bottom. R. E. D. 541. Colls., B. Parsons and R. E. Dickerson.

465. Mt. Pinos Quadrangle. Tejon group. Vicinity of Salt Creek. S. E.  $\frac{1}{4}$  of N. W.  $\frac{1}{4}$  of Sec. 32, T. 10 N., R. 20 W., Mt. S. B., B. L. and M., 25 feet below hilltop and 75 feet below white Miocene conglomerate. R. E. D. 543. Colls., B. Parsons and R. E. Dickerson.

## COWLITZ PHASE OF TEJON GROUP.

### STRATIGRAPHY.

Dr. Weaver described the Cowlitz phase as follows: "In southern Lewis County, east of Little Falls, there exist shales and shaly limestones containing a fauna seemingly older than the typical Tejon, but more closely related to it than to the Martinez or lower Eocene of California. A very large number of the species are new and the fauna may represent a transition from the Martinez to the Tejon—a fauna which as yet is unknown in California. In order to distinguish this from the typical Tejon, the term Cowlitz formation is suggested.

.....

The Cowlitz formation contains the following fauna:

### PELECYPODA

<i>Barbatia morsei</i> Gabb	<i>Meretrix olequahensis</i> , n.sp.
<i>Cardium breweri</i> Gabb	<i>Ostrea fettkei</i> , n.sp.
<i>Cardium cooperi</i> Gabb	<i>Pecten cowlitzensis</i> , n.sp.
<i>Corbula</i> , sp.	<i>Placunanomia inornata</i> Gabb
<i>Crassatella washingtoniana</i> , n.sp.	<i>Venericardia alticosta</i> Gabb
<i>Crassatella cowlitzensis</i> , n.sp.	<i>Venericardia planicosta</i> Lam- arck.

### GASTROPODA

<i>Ancillaria bretzi</i> , n.sp.	<i>Fusus washingtoniana</i> , n.sp.
<i>Cassidaria washingtoniana</i> , n.sp.	<i>Galerus excentricus</i> Gabb
<i>Conus cowlitzensis</i> , n.sp.	<i>Hemifusus sopenahensis</i> , n.sp.
<i>Cylichna costata</i> Gabb	<i>Hemifusus cowlitzensis</i> , n.sp.
<i>Fusus lewisensis</i> , n.sp.	<i>Hemifusus lewisensis</i> , n.sp.
<i>Fusus dickersoni</i> , n.sp.	<i>Hemifusus tejonensis</i> , n.sp.
	<i>Hemifusus washingtoniana</i> , n.sp.

<i>Fasciolaria washingtoniana</i> , n.sp.	<i>Nassa packardi</i> , n.sp.
<i>Lunatia hornii</i> Gabb	<i>Naticina obliqua</i> Gabb
<i>Murex sopenahensis</i> , n.sp.	<i>Ranella washingtoniana</i> , n.sp.
<i>Murex cowlitzensis</i> , n.sp.	<i>Ranella cowlitzensis</i> , n.sp.
<i>Mitra washingtoniana</i> , n.sp.	<i>Rimella canalifera</i> Gabb var. elongata new var.
<i>Morio tuberculatus</i> Gabb var.	<i>Surcula cowlitzensis</i> , n.sp.
trituberculatus new var.	<i>Tritonium sopenahensis</i> , n.sp.
<i>Nassa eocenica</i> , n.sp.	<i>Turritella uvasana</i> Conrad.

## BRACHIOPODA

*Rhynchonella washingtoniana*, n.sp.

## SHARKS' TEETH

There is a total of forty-five species occurring in this formation. Out of the total fauna thirty are new species. The base of this formation is unknown. Its known thickness is at least five hundred feet. Future studies may show this to be really a part of the Tejon formation".

Dr. Weaver's present opinion is that the Cowlitz phase is uppermost Tejon and that it is to be correlated with the *Siphonalia sutterensis* Zone.

Mr. Bruce Martin described conditions at the two principal collecting localities 182 and 183, Cal. Acad. Sci. as follows:

"Locality 182 is on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. This is Professor Weaver's University of Washington locality 1. The formation here consists of blue sandy clay or mudstone. There are a few prominent strata of concretionary sandstone interstratified with the clay. The strike is N. 40° W., dip 5°-10° N. The formation extends southward down the river for some distance and fossils may be obtained from the banks for a half mile or more. . . . . The tops of the hills between Vader (Little Falls) and Olequah are mantled with basalt and the sandstone is exposed only in the creeks which have cut through the lava cap.

Locality 183 is in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182".

It will be seen from this description that Locality 183 is stratigraphically lower than Locality 182. The stratigraphy around Vader is evidently not so simple as Martin's description quoted above might lead one to infer. Martin states that the strata at locality 184, another Tejon locality on Olequah Creek one mile north of Vader have a strike of N. 35° W. and a dip of 60° E. A plot of these localities about Vader shows that some faulting or acute folding has taken place between localities 184 and 182.

## FAUNA

The following species have been identified from localities 182 and 183. The ones marked by a star were reported by Dr. Weaver but are not in the Academy collections.

## LIST OF SPECIES FROM COWLITZ PHASE.

	182	183	Weaver	Type Tejon
<i>Terebratulina washingtoniana</i> (Weaver).....	×			
<i>Acila</i> , n.sp. ....		×		×
<i>Barbatia morsel</i> Gabb. ....		×	•	×
<i>Corbula hornii</i> Gabb. ....		×	•	×
<i>Crassatellites Washingtoniana</i> Weaver. ....		×	•	×
<i>Crassatellites grandis</i> (Gabb) .....		×	•	×
<i>Crassatellites cowlitzensis</i> (Weaver) .....		×	•	×
<i>Cardium breweri</i> Gabb. ....		×	•	×
<i>Cardium Cooperii</i> Gabb. ....		×	•	×
<i>Diplodonta polita</i> (Gabb) .....	×			×
<i>Glycimeris sagittata</i> (Gabb) .....		×		×
<i>Leda gabbi</i> Conrad. ....	×	×		×
<i>Leda vaderensis</i> , n.sp. ....		×		×
<i>Marcia quadrata</i> (Gabb) .....	×	×		×
<i>Macrocallista</i> (?) <i>andersoni</i> , n.sp. ....	×	×		×
<i>Macrocallista vaderensis</i> , n.sp. ....		×		×
<i>Meretrix olequahensis</i> Weaver. ....		×		×
<i>Meretrix cf. ovalis</i> Gabb. ....		×		×
<i>Nucula</i> , sp. ....	×			
<i>Ostrea fettkei</i> Weaver. ....		×		
<i>Ostrea idriaensis</i> Gabb. ....		×		×
<i>Pecten cowlitzensis</i> Weaver. ....		×	•	
<i>Psammobia</i> , sp. ....		×		
<i>Psammobia hornii</i> (Gabb) .....	×		•	×
<i>Placunanomia inornata</i> Gabb. ....		×		×
<i>Semele</i> (?) <i>diaboli</i> , n.sp. ....		×		
<i>Thracia dilleri</i> Dall. ....		×		
<i>Tellina sutterensis</i> Dickerson. ....	×			×
<i>Tellina longa</i> Gabb. ....		×		
<i>Teredo</i> , sp. ....		×		
<i>Venericardia planicosta hornii</i> (Gabb) .....	×	×		×
<i>Cadulus pusillus</i> (Gabb) .....		×		×
<i>Dentalium stramineum</i> Gabb. ....	×	×		×
<i>Ancillaria bretei</i> Weaver. ....	×	×		×
<i>Amauropis alveata</i> (Conrad) .....	×			×
<i>Amphissa eocenica</i> (Weaver) .....		×		
<i>Amphissa packardii</i> (Weaver) .....		×		
<i>Bursa washingtoniana</i> (Weaver) .....	×	×		×
<i>Bursa cowlitzensis</i> (Weaver) .....	×			×
<i>Calyptrea excentrica</i> (Gabb) .....	×	×		×
<i>Crepidula pileum</i> Gabb. ....	×	×		×
<i>Cylichna costata</i> Gabb. ....	×			×
<i>Cancellaria stantoni</i> Dickerson. ....		×		×
<i>Cantharus perrini</i> , n.sp. ....		×		
<i>Conus weaveri</i> , n.sp. ....	×			×
<i>Conus cowlitzensis</i> Weaver. ....				
<i>Conus remondii</i> Gabb. ....	×			×

June 15, 1915.

## LIST OF SPECIES FROM COWLITZ PHASE.—(Cont.)

	182	183	Weaver	Type Tejon
<i>Drillia ornata</i> , n.sp.	x			
<i>Exilia perkinsiana</i> (Cooper)	x	x		x
<i>Exilia dickersoni</i> (Weaver)	x	x		x
<i>Ficus mamillatus</i> Gabb.	x			x
<i>Fusus washingtoniana</i> Weaver	x			
<i>Fusus lewisensis</i> Weaver	x	x		
<i>Fusus willisi</i> , n.sp.				
<i>Pasciolaria buwaldana</i> , n.sp.	x			
<i>Picopeda cowlitzensis</i> (Weaver)	x			x
<i>Galeodea tuberculata</i> (Gabb)	x			x
<i>Hemifusus sopenahensis</i> Weaver	x			
<i>Hemifusus lewisiana</i> Weaver		x		
<i>Hemifusus washingtoniana</i> (Weaver)	x			
<i>Hemifusus tejonensis</i> Weaver		x		
<i>Lunatia cowlitzensis</i> , n.sp.	x			
<i>Lunatia nuciformis</i> Gabb		x		x
<i>Mitra washingtoniana</i> Weaver	x	x		
<i>Murex packardi</i> , n.sp.	x			
<i>Murex sopenahensis</i> Weaver	x			x
<i>Melania fettkei</i> (Weaver)	x	x		
<i>Melania packardi</i> , n.sp.		x		
<i>Melania vaderensis</i> , n.sp.		x		
<i>Monodonta wattsi</i> Dickerson		x		
<i>Neverita weaveri</i> , n.sp.	x			
<i>Neverita secta</i> Gabb	x			x
<i>Neritina martini</i> , n.sp.		x		
<i>Nerita cowlitzensis</i> , n.sp.		x		
<i>Naticina obliqua</i> Gabb		x		x
<i>Nyctiochus washingtoniana</i> (Weaver)	x			x
<i>Niso polito</i> Gabb	x			x
<i>Odotomia</i> , n.sp.		x		x
<i>Olivella mathewsonii</i> Gabb		x		x
<i>Pseudoliva inornata</i> , n.sp.		x		x
<i>Rimella simplex</i> Gabb	x	x		x
<i>Rimella elongata</i> (Weaver)	x	x		
<i>Siphonalia bicarinata</i> , n.sp.		x		x
<i>Surcula washingtoniana</i> (Weaver)	x			x
<i>Surcula cowlitzensis</i> Weaver	x			x
<i>Turris pulchra</i> , n.sp.	x			
<i>Turris</i> , n.sp.		x		x
<i>Turris monilifera</i> Cooper		x		
<i>Turris cf. monilifera</i> Cooper		x		
<i>Turritella uvasana</i> Conrad	x	x		x
<i>Turritella</i> , n.sp.	x			x
<i>Turritella</i> , n.sp.		x		x
<i>Triforis washingtoniana</i> , n.sp.		x		
<i>Urosalpinx hannibali</i> , n.sp.	x	x		

COMPARISON OF COWLITZ AND TYPE TEJON  
FAUNAS

The close connection between the Cowlitz phase of the Washington Tejon and the fauna of the type Tejon is easily seen when the table of the Cowlitz fauna is studied. (See list above.) About 55 of a total of 95 species listed from Washington are found in the fauna of the type Tejon. Of the remainder, three are not specifically determined, and about 20 are represented by only one or two individuals. Such characteristic and most abundant species as *Acila gabbiana*, *Barbatia morsci*, *Corbula hornii*, *Crassatellites grandis*, *Cardium*

*brewerii*, *Cardium cooperii*, *Diplodonta polita*, *Glycimeris sagittata*, *Leda gabbi*, *Marcia quadrata*, *Ostrea idriaensis*, *Psammobia hornii*, *Placunanomia inornata*, *Tellina longa*, *Venericardia planicosta hornii*, *Cadulus pusillus*, *Dentalium stramineum*, *Amauropsis alveata*, *Bursa washingtoniana*, *Bursa cowlitzensis*, *Calyptraea excentrica*, *Crepidula pileum*, *Cylichna costata*, *Cancellaria stantoni*, *Conus weaveri*, *Conus remondii*, *Conus cowlitzensis*, *Exilia perkinsiana*, *Exilia dickersoni*, *Ficopsis cowlitzensis*, *Galeodea tuberculata*, *Lunatia nuciformis*, *Murex sopenahensis*, *Neverita secta*, *Naticina obliqua*, *Nyctilochus washingtoniana*, *Niso polito*, *Olivella mathewsonii*, *Rimella simplex*, *Surcula washingtoniana*, *Surcula cowlitzensis*, *Turris*, n. sp., *Turritella uvasana*, *Turritella*, n. sp., *Turritella*, n. sp., are found in both faunas. This list well illustrates the fact that characteristic, abundant species are best for correlation purposes and that a mere percentage method which does not consider the abundance of individual species is very apt to be unreliable. The faunal differences are no greater than one might expect from separation by several degrees of latitude.

### SUMMARY

(1.) The fauna of the type locality of Tejon group is a unit and it corresponds to the *Rimella simplex* Zone of the Mount Diablo region.

(2.) The beds composing the Tejon of the type locality are likewise a formational unit, but upper Eocene strata both older and younger than these occur in other parts of California.

(3.) The Cowlitz phase of the Tejon of Washington appears to represent the same faunal facies as the fauna of the type Tejon, i. e., the *Rimella simplex* Zone is present in both localities.

### DESCRIPTIONS OF SPECIES

#### *Leda uvasana*, new species

Plate 1, figures 2a, 2b

Shell of medium size, elongate, with a very small inconspicuous central beak; anterior dorsal margin slightly convex with a slight slope to a narrowly rounded anterior extremity; posterior dorsal margin concave, ending in a sharply pointed



rostrum; ventral margin very broadly rounded; escutcheon lanceolate, distinct; lunule indistinct. This species has less thickness than *L. gabbi* Conrad and quite a different shape. Its ribbing is somewhat finer. Figure 1, Plate 1 illustrates *L. gabbi* well and brings out the differences at a glance.

Dimensions:—Height of broken type, 10mm.; length, 18mm.; convexity, 2mm.

Type:—No. 250, and cotype, No. 251, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California, Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley, and about three miles due east of the mouth of Cañada de las Uvas (Grapevine Creek). Coll., Bruce Martin.

Named for its occurrence in the vicinity of Cañada de las Uvas.

***Leda vaderensis*, new species**

Plate 1, figure 3

Shell robust, thick, with prominent, central beak; anterior dorsal margin slightly convex, sloping toward a well rounded anterior; posterior dorsal margin concave; ventral margin convex resembling that of *L. gabbi* closely; decoration consisting of very fine, round concentric ribs. This species differs from *L. gabbi* in its finer ribbing, in its greater convexity, and in the central position of its beak.

Dimensions:—Height, 7mm.; length, 13mm.; convexity, 2mm.

Type:—No. 252, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River, about one and three-fourths miles southeast of Vader, Washington. Coll., Bruce Martin.

Named for its occurrence near Vader, Washington.

***Glycimeris ruckmani*, new species**

Plate 1, figures 5a and 5b

Shell of moderate size with acutely pointed beaks; dorsal margins sloping steeply to join a broadly rounded ventral margin; the posterior dorsal margin slightly convex and with a gentler slope than the straight anterior dorsal margin; decoration consisting of about 28 rounded radial ribs crossed by concentric growth lines; area semilunar and marked by impressed lines curving outward from the altitude line.

This species differs from *Glycimeris cor* in having a more pointed beak, in lack of hinge teeth in the central portion of its hinge and in general shape. *Glycimeris cor* Gabb is figured for comparison. (See Plate a, figure 6).

Dimensions:—Height of type, 19mm.; length, 17mm.; convexity, 6mm.

Type:—No. 11051, University of California. Locality 458, Tejon Quadrangle. Tejon group. West side of Grapevine Creek, elevation 2050 feet, about  $4\frac{1}{2}$  miles S.  $6^{\circ}$  W. of 1085 B. M.; about 400 feet (stratigraphically) above Basement Complex-Tejon contact. R. E. D. 536. Coll., R. E. Dickerson.

Named in honor of Mr. John Ruckman.

***Meretrix tejonensis*, new name**

Plate 3, figures 2a and 2b

*Meretrix uvasana* Gabb, *not* Conrad, Gabb, W. M., Geology of California, Palaeontology, vol. 1, pp. 163-164, 1864.

Gabb's description is as follows:

"Shell thick, oval, robust, a fourth longer than wide, very inequilateral; beaks large, strongly incurved, placed less than a third of the length from the anterior end; buccal margin prominently rounded below, deeply excavated under the beaks; cardinal margin sloping very convexly towards the posterior end, which is subtruncated. Surface marked by small lamelliform ribs, separated by spaces about equal to four times the thickness of the ribs themselves; the interspaces are sometimes plain, sometimes striated. Inner margin plain.

Localities: Abundant near Fort Tejon, whence it was described by Mr. Conrad; also found not rarely, near Martinez, and nearly everywhere in Division B.

This is the largest species of the genus, and one of the commonest fossils in California. The figure given in the Pacific Railroad Report is from a fragmentary specimen, and conveys a very incorrect idea of the outline of the shell. There can be no doubt of the identity of the present form with Mr. Conrad's species, since I collected numerous specimens myself, at the original locality; and this is the only species with the peculiar surface ornamentation, mentioned by Mr. Conrad, that has been found in California."

It appears that Gabb was mistaken concerning "the only species with the peculiar surface ornamentation," as the individuals figured as figures 3a and 3b on Plate 3 show. These forms are very close to Conrad's figure of *M. uvasana*, and the writer believes that the forms illustrated are cotypes of Conrad's species. All of the four specimens figured as 2a, 2b, 3a, 3b came from Cal. Acad. Sci. locality 244. On this account the writer proposes a new name for the species redescribed by Gabb as *M. uvasana*.

***Macrocallista vaderensis*, new species**

Plate 3, figures 5a, 5b, 5c

Shell trigonal, with beak a third of shell length from broadly rounded anterior end; posterior dorsal margin sloping to a sharply pointed posterior; broadly rounded anterior extending from beak to nearly straight ventral margin; lunule and escutcheon, indistinct. The trigonal form of this species makes it easily distinguishable from other Eocene Veneridæ.

Dimensions:—Height, 19mm.; length, 26mm.; convexity, 7mm.

Type:—No. 267, and cotype No. 268, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader, Washington. Coll., Bruce Martin.

Named for its occurrence near Vader, Washington.

***Macrocallista* (?) *andersoni*, new species**

Plate 4, figures 1a, 1b

Shell elliptical in outline; medium size; beak prominent, a third of shell length from anterior end; posterior dorsal margin nearly straight; posterior end subtruncate; anterior end well rounded; lunule and escutcheon distinct; a well marked shallow umbonal groove extending to the ventral margin near posterior end; hinge characters unknown; numerous lines of growth decorating shell. The umbonal groove is the unique character of this species and serves to distinguish it from other west coast venerid forms.

Dimensions:—Length, 39mm.; height, 25mm.

Type:—No. 269, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about  $\frac{3}{4}$  mile from its mouth. Coll., Bruce Martin.

Named in honor of Mr. F. M. Anderson, Curator, Department of Invertebrate Paleontology, California Academy of Sciences.

***Tellina howardi*, new species**

Plate 4, figures 2a and 2b

Shell large, oval, compressed; beak anterior of center; anterior and posterior dorsal margins nearly straight sloping gently; anterior end rounded more broadly than posterior; ventral margin with very great curvature. This is the largest *Tellina* in the Tejon-Eocene.

Dimensions:—Length of broken type, 43mm.; height, 30mm.

Type:—No. 271, and cotype, No. 272, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., B. Martin.

Named for Delle Howard Dickerson who has aided the writer in his paleontological studies.

***Semele diaboli*, new species**

Plate 4, figure 4

Shell of medium size; beak sub-central; anterior dorsal margin sloping gently to a well rounded anterior end; posterior dorsal margin sloping steeply to a sharply rounded posterior; decoration, concentric growth lines only.

Dimensions:—Length, 31mm.; height, 24mm.

Type:—No. 11052, University of California. Locality 469, Mount Diablo Quadrangle, Contra Costa County, California. Tejon group. Near middle of S. E.  $\frac{1}{4}$  of Sec. 21, T. 1 S., R. 1 E., Mt. D. B. L. and M., elevation 1350 feet, on north side of ridge. Coll., R. E. Dickerson.

Named for the occurrence in the vicinity of Mount Diablo.

***Corbula harrisi*, new species**

Plate 4, figure 6

Shell small, thick, subtrigonal, with beak central, slightly prosogyrate; anterior dorsal slope slightly steeper than the moderately steep posterior dorsal slope; base broadly rounded; posterior end sharply rounded; a faint umbonal slope extending to the point between the posterior end and the base; shell decorated by faint radial ribbing which is strongest at posterior end along the umbonal slope and by concentric growth lines. Interior of shell is unknown and hence generic reference is doubtful. This species is not so thick as *C. parilis* Gabb and its concentric ribbing is not so strong.

Dimensions:—Length, 6mm.; height, 4mm.; convexity, 1.5mm.

Type:—No. 275, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about three-quarters of a mile from its mouth. Coll., B. Martin.

Named in honor of Professor G. D. Harris of Cornell University.

***Corbula uvasana*, new species**

Plate 4, figure 7

Shell small, inflated with central beak, anterior dorsal margin slightly concave with moderate slope to a subtruncate anterior end; posterior dorsal margin with slight slope to a broadly rounded posterior; ventral margin broadly rounded. Faint radial lines and feeble concentric growth lines decorate this shell. Interior unknown.

Dimensions:—Length, 7mm.; height, 5mm.; convexity, 2mm.

Type:—No. 276, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In bank of Live Oak Creek about three-quarters of a mile from its mouth. Coll., Bruce Martin.

Named for its occurrence near Cañada de las Uvas.

**Neverita weaveri**, new species

Plate 4, figures 10a, 10b

Shell small, subglobose with very low spire of three whorls; aperture semilunar, entire; outer lip thin, curving backward; umbilicus completely covered in the type, a mature specimen, but partially open in young forms; outer lip and umbilicus in same plane which cuts axis of shell at a forty-five degree angle.

The umbilicus of this species resembles that of *N. callosa* Gabb very closely but its low spire renders it easily separable from *N. callosa*.

Dimensions:—Length, 9mm.; width of body-whorl, 11mm.

Type:—No. 278, and cotype, No. 279, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for Professor C. E. Weaver, University of Washington.

**Lunatia cowlitzensis**, new species

Plate 4, figures 12a, 12b

Shell of medium size, high with five rounded whorls; umbilical chink small, long, narrow; callus long, slightly widening above umbilical chink; aperture semilunar.

This species has apparently two different forms one of which is slightly higher than the other. Possibly these two forms represent sex differences.

This species has a higher spire than *L. hornii* Gabb, (See Plate 4, figure 4). It resembles *L. shumardiana* Gabb very closely but the callus appears to be slightly different.

Dimensions:—Length, 30mm.; width of body-whorl, 21mm.

Type:—No. 281, and cotype, No. 282, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. This is Professor Weaver's University of Washington Locality 1.

Named for its occurrence on the Cowlitz River, Washington.

***Turritella uvasana bicarinata*, new variety**

Plate 5, figure 2

This variety which is found associated with the typical *T. uvasana* at Cal. Acad. Sci. Locality 244 differs from the typical form in that the lower portion of the whorls are marked by two unusually strong carinæ with a thread between. Intergrades are found between this form and the typical *T. uvasana*. These two carinæ give the whorls a form somewhat similar to *T. martinezensis* of the Martinez group and quite different from the well rounded whorls of the typical *T. uvasana*.

Type:—No. 285, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., Bruce Martin.

***Turritella uvasana tricarinata*, new variety**

Plate 5, figure 4

This variety also occurs with the above described variety which it resembles closely but differs by having three strong carinæ instead of two.

Type:—No. 287, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., Bruce Martin.

***Nerita cowlitzensis*, new species**

Plate 5, figures 7a, 7b

Shell very small with spire immersed; whorls three, rapidly increasing in size; surface of subglobose body-whorl divided into three portions by a strong spiral line at the shoulder and a second medial one; mouth semilunar; outer lip thickened, dentate; callus heavy, closing umbilicus completely; beaded spiral threads crossed by axial ribs decorating shell.

This species is less angulated than *N. triangulata* Gabb and its spiral threads are beaded.

Dimensions:—Length, 7mm.; width of body-whorl, 8mm.

Type:—No. 290, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for its occurrence on Cowlitz River, Washington.

***Neritina martini*, new species**

Plate 5, figures 8a, 8b

Shell medium in size with two and a half whorls; spire immersed; body-whorl very wide, rounded to sub-quadrate, with flattened top which is perpendicular to axis of shell; outer lip sharp, smooth within, entire; callus large with straight interior edge which is slightly dentate; surface decorated by sinuous axial growth lines.

This is the first representative of this genus reported from the West Coast Eocene.

Dimensions:—Length, 18mm.; width of body-whorl, 21mm.

Type:—No. 291, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named in honor of Mr. Bruce Martin who collected the species at its type locality.

***Rimella elongata* (Weaver)**

Plate 6, figure 2

*Rimella canalifera elongata* Weaver, C. E. "A Preliminary Report on the Tertiary Palaeontology of Western Washington". Bull. 15, Wash. Geol. Surv., pp. 37-38, 1912.

The specimen figured agrees with Weaver's description and since it came from the type locality of the species it is evidently the same. It differs so very much from *R. canalifera* Gabb that it was thought best to raise it to specific rank. Dr. Weaver pointed out these differences very well. "This variety is characterized by ten instead of six or seven whorls, by its more slender form, and differences in external ornamentation."



Unfortunately his figures do not correspond to the description. The number of axial ribs of this species is much greater than in *R. canalifera*. The differences between this species and *R. simplex* Gabb are readily seen upon comparing the figures. (See Plate 6, figures 1a, 1b).

***Cypræa mathewsonii* Gabb**

*Cypræa Mathewsonii* Gabb, W. M., Geol. Calif. Palæontology, vol. 2, p. 164, 1868.

Plate 6, figure 5

This small form is abundant at Cal. Acad. Sci. Locality 245. It differs from *C. bayerquei* Gabb, (See Plate 6, figure 4a, 4b) in its greater thickness and in its shorter length. It is not common at most Tejon localities and as far as known it is characteristic of the Rimella simplex Zone. *Cypræa bayerquei* has apparently the same upper limit.

***Melania packardi*, new species**

Plate 6, figure 6

Shell elongate, slender, with flat sided whorls; about twelve parallel axial ribs which are crossed by six or seven weaker spiral lines decorate each whorl; rectangular spaces between two sets of lines having greater length parallel to spiral lines; suture wavy, distinct.

This species is readily recognized by its characteristic decoration.

Dimensions:—Length of broken type, 18mm.; width of body-whorl, 8mm.

Type:—No. 299, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for Mr. Earl L. Packard who collected many specimens from this locality.

***Melania vaderensis*, new species**

Plate 6, figure 7

Shell elongate-conic with nearly flat sided whorls; whorls decorated by seventeen or eighteen slightly sinuous axial ribs crossed by four spiral lines of nearly equal strength; suture wavy, distinct.

This species differs from *M. packardi* in the decoration of its whorls and a greater apical angle.

Dimensions:—Length of broken type, 19 mm.; width of body-whorl, 6 mm.

Type:—No. 300, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for its occurrence near Vader, Washington.

***Ficopsis remondii* Gabb, *Ficopsis hornii* Gabb, *Ficopsis cooperii* Gabb, *Ficopsis cowlitzensis* (Weaver)**

*Ficopsis remondii* Gabb, W. M., Geol. Calif. Palaeontology, vol. 1, p. 87, 1864.

*Ficopsis hornii* Gabb, W. M., Geol. Calif. Palaeontology, vol. 1, p. 86, 1864.

*Ficopsis cooperii* Gabb, W. M., Geol. Calif. Palaeontology, vol. 1, p. 86, 1864.

*Hemifusus cowlitzensis* Weaver, C. E., Wash. Geol. Surv. Bull. 15, p. 45, 1912.

Plate 6, figures 8, 9, 10, 11, 12

This very natural group is represented in the Tejon fauna by *Ficopsis remondii* Gabb, *F. hornii* Gabb, *F. cooperii* Gabb and *F. cowlitzensis* (Weaver). Conrad also included *Ficus mamillatus* Gabb in this group as well, but it appears to belong to the genus *Ficus*, as it lacks the relatively higher spire of *Ficopsis*, its body-whorl is more globose and its outer lip has no tendency to become angulated.

*Ficopsis remondii* Gabb is sometimes almost without marked angulation but in general, the specimen figured (See Plate 6, figure 8) represents a typical form. This species lacks any marked nodosity at the shoulder or upon the two carinæ below it.

*Ficopsis cowlitzensis* (Weaver) is an intermediate form, that is, it bears certain resemblances to *F. remondii* on the one hand and to *F. hornii* on the other. It differs from *F. remondii* in that its shoulder is more definitely set off and in that the carinæ are more definite and are always nodose. Its nodes

are more numerous than those of *F. hornii*, its shoulder is more sloping and the three carinæ are equally spaced instead of having a markedly different spacing as in the other species.

*Ficopsis cooperii* is much closer to *F. hornii* than to other members of this genus, but its square shoulder is without even the small slope of *F. hornii*, its spiral threads are finer and the three rows of nodes are unequally spaced but in reverse order the two upper rows being the closer together.

The range of these species brings out some interesting relationships. *F. remondii*, *F. hornii* and *F. cowlitzensis* are associated at the type locality on the Cañada de las Uvas. *F. cooperii* and *F. remondii* are found at San Diego. The general assemblage of forms at San Diego and the type Tejon represent the same faunal zone. *Ficopsis cooperii* also occurs in the *Siphonalia sutterensis* Zone of Oregon. It is apparent from this distribution that these forms are not directly evolved in a simple time order, that is, one form does not appear to have originated from another but they appear to represent end members of branchings from a common ancestor of an earlier period and possibly sometime when well preserved species of this genus are found in the Martinez group, a more nearly complete history of the group may be written.

#### ***Pseudoliva inornata*, new species**

Plate 7, figures 1a, 1b, 1c

Shell pyriform, solid with thick shell; six whorls; the flat sided spire forming a cone which rests upon the body-whorl whose upper portion has a slightly lesser slope than the spire; body-whorl slightly swollen, elongate; suture linear; canal short, reverted; siphonal fasciole moderately developed; decoration consisting of axial growth lines only.

The lack of marked decoration and the nearly smooth surface of the shell, and the elongate form are characters which separate this species from other West Coast Eocene forms belonging to the genus *Pseudoliva*.

Dimensions:—Length, 32 mm.; width of body-whorl, 18 mm.

Type:—No. 11053, University of California. Locality 458, Tejon Quadrangle. Tejon group. West side of Grapevine Creek, elevation 2050 feet, about four and one-half miles S.

6° W. of 1085 feet B. M.; about 400 feet above Basement Complex—Tejon contact. R. E. D. 536. Coll. R. E. Dickerson.

***Pseudoliva tejonensis*, new species**

Plate 7, figure 2

Shell pyriform, solid with thick shell substance; five whorls; the flat-sided spire whorls forming a cone which rests upon top of the body whorl; suture wavy, appressed and bordered by a rounded ridge on the body whorl; posterior sinus narrow, sharp and moderately deep; aperture oval with greatest width medial; inner lip thinly calloused; umbilicus imperforate; canal short, reverted; siphonal fasciole well developed; sulcus medial; decoration consisting of many fine spiral lines crossed by equally fine axial threads.

Dimensions:—Length, 39 mm.; width of body-whorl, 27 mm.

Type:—No. 308, Cal. Acad. Sci. Locality 245, Tejon Quadrangle, Kern County, California. Tejon group. Along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about thirty-five miles south of Bakersfield, California. Coll., Bruce Martin.

Named for its occurrence in the Tejon group.

***Triforis washingtoniana*, new species**

Plate 6, figure 13

Shell elongate, conic with nine nearly plane-sided whorls, whorls decorated by three rows of nodes made by the crossing of three strong spiral lines and about eighteen axial ribs which are parallel to axis; one or two intercalary threads occur between the horizontal rows of nodes; suture indistinct.

Dimensions:—Length, 20 mm.; width of body-whorl, 45 mm.

Type:—No. 362, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for its occurrence in Washington.

**Nyctilochus kewi**, new species

Plate 7, figures 5a, 5b

Shell stout, with six whorls; spire only two-fifths the length of shell; the first two whorls smooth, the third, fourth and fifth whorls slightly convex and decorated by four strong spiral lines with a thread between each two and by fourteen axial ribs which make rounded nodes at the intersections with spiral ribs; of the spiral ribs, the lower two are the strongest and they occur near the base of the whorl at the place of greatest width; decoration of the body whorl similar to the decorated spire whorls; the largest spiral rib marking the shoulder which is located two-fifths of the whorl length below its sinuous suture; the spiral ribs above and below the shoulder not as well marked as those on the upper whorls; two rounded varices extending over the whorls; these varices about 180° apart being slightly discontinuous; canal short, twisted; mouth broadly oval. This species has a shorter spire than *Bursa cowlitzensis* (Weaver) or *Bursa washingtoniana* (Weaver). Its nodes are rounded instead of pointed like those of *Bursa washingtoniana* (Weaver).

Dimensions:—Length of spire, 21 mm.; width of body whorl, 15 mm.

Type:—No. 11054, Univ. Calif. Locality 458, Tejon Quadrangle, Kern County, California. Tejon group. West side of Grapevine Creek, elevation 2050 feet about four and one-half miles S. 6° W. of 1085 B. M.; about 400 feet (Stratigraphic) above Basement Complex—Tejon contact. R. E. D. 536. Coll., R. E. Dickerson.

Named in honor of Mr. Wm. Kew, who has assisted the writer upon many occasions in investigations of the Eocene of California.

**Bursa washingtoniana** (Weaver)

*Ranella washingtoniana* Weaver, C. E., Wash. Geol. Surv. Bull. 15, p. 41, 1912.

Plate 7, figures 4, 6

This species is a variable one and weathering sometimes obscures the finest spiral lines or removes them entirely. On this account the specimens collected at the type Tejon appear to be slightly different (See Plate g, figure 4) from typical forms. Fortunately several specimens from Locality 245 are

available and the study of these forms demonstrates their identity with *Bursa washingtoniana*. One specimen from Locality 245 appears to have a slightly higher spire than the Washington forms but this specimen is a larger one than any of the forms from the north and comparative material shows that this is a variation due to growth. Younger individuals are the same in form and decoration as *B. washingtoniana*.

*B. washingtoniana* at the type locality of the species varies as respects the strength of nodes and position of varices. The closely allied forms *Nyctilochus californicus*, *N. hornii* and *N. washingtoniana* are introduced for comparison (See Plate 7, figures 7, 8, 9).

***Cantharus perrini*, new species**

Plate 7, figures 10a, 10b

Shell small, short, stout with large inflated body-whorl marked by strong spiral lines which alternate in size; whorls six; first two smooth; third, fourth and fifth whorls flat-sided and decorated by three strong spiral lines with two of lesser strength between; body-whorl decorated by eight or nine strong spiral lines with alternating threads; aperture oval; outer lip dentate and lirate within; siphonal fasciole well developed; umbilicus subimperfurate.

Dimensions:—Length, 12 mm.; width of body-whorl, 7 mm.

Type:—No. 315 Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington. Coll., Bruce Martin.

Named in honor of Professor J. Perrin Smith of Stanford University.

***Chrysodomus ruckmani*, new species**

Plate 7, figure 11

Shell solid, spindle-shaped, with six or seven whorls; spire moderately elevated, consisting of five or six very slightly rounded whorls; whorls decorated by six to eight spiral lines with small threads in the interspaces; five incremental lines crossing the spiral lines; suture linear, distinct; body-whorl rounded and nearly twice as long as the spire; aperture large, widest in middle, and terminating in a twisted canal; outer lip simple; inner lip slightly incrustated.

June 15, 1915.

This species resembles *C. mucronata* (Gabb) in decoration but its whorls are far less rounded and its spire is much shorter.

Dimensions:—Length of imperfect type, 22 mm.; width of body whorl, 11 mm.

Type:—No. 11055, Univ. California. Locality 452, Tejon group. Cañada de las Uvas, the type locality of this group. On road to Grapevine Creek, S. W.  $\frac{1}{4}$  of S. E.  $\frac{1}{4}$ , Sec. 29, T. 10 N., R. 19 W. Coll., R. E. Dickerson.

Named for John Ruckman, who assisted the writer in identifying the fauna of this locality.

***Siphonalia bicarinata*, new species**

Plate 8, figures 1a, 1b, 1c, 1d

Shell, fusiform; whorls seven, decorated by two spiral rows of twelve nodes; shoulder of whorl distinct, nodose; portion between shoulder and wavy suture marked by spiral threads of sub-equal strength; portion below shoulder marked by ribs of variable strength; body-whorl large, with biangular outer lip.

The two rows of nodes of this species make it easily separable from *Siphonalia sutterensis* Dickerson. The young individuals exhibit less accentuated characters than the older. (See figures 1c, 1d.)

Dimensions:—Length, 20 mm.; width of body-whorl, 11 mm.

Type:—No. 316, and cotype, No. 317, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of locality 182. Coll., B. Martin.

***Molopophorus tejonensis*, new species**

Plate 8, figures 3a, 3b

Shell biconical with very short recurved canal; spire short, with five flat sided whorls; suture distinct, linear; bordered by a narrow but distinct collar; decoration of each spire whorl consisting of about seven spiral lines crossed by about thirty slightly sinuous lines; axial ribs, sub-equal in strength; small rounded nodes present at crossing of two sets of lines; decoration of body whorl similar except for three closely spaced

spiral lines which are found in the slight concavity of the body-whorl just below the suture; siphonal fasciole of two sharp ridges with smooth channel between; aperture semioval; outer lip thin, sharp; inner lip covered by a thin callus.

This species lacks the sharp axial ribs of *Molopophorus striata* (Gabb) but its spiral decoration is more pronounced. (See Plate 8, figure 3c for comparison.) Only one specimen of *M. striata* was found and that one is evidently immature. If more comparative material were available possibly it might be shown that *M. tejonensis* is merely a mature form of *M. striata*, but it was thought best to describe *M. tejonensis* as a new species as its characters are markedly different.

Dimensions:—Length, 20 mm.; width of body-whorl, 11 mm.

Type:—No. 320, Cal. Acad. Sci. Locality 245, along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about 35 miles south of Bakersfield, California. Col., Bruce Martin.

Named for its occurrence in the Tejon group at its type locality.

#### **Hemifusus sopenahensis** Weaver

*Hemifusus sopenahensis* Weaver, C. E., Wash. Geol. Surv. Bull. 15, p. 44, 1912.

Plate 8, figures 2a, 2b

The young individuals of this species have characters like the genus *Nyctilochus*. The body-whorl in mature forms is more elongate and the axial ribbing less pronounced.

#### **Hemifusus volutæformis**, new species

Plate 8, figures 4a, 4b

Shell small, solid, with five or six distinctly angulated whorls; whorls of the spire decorated by thirteen or fourteen axial ribs and by equally spaced spiral lines. The shoulder of the penultimate whorl which is well preserved located at a point two-fifths the whorl-length below the suture; the slope between the appressed suture and the shoulder concave and covered by spiral lines; the body-whorl decorated similarly to the spire-



whorls; shoulder of the body-whorl only a slight distance below the suture; aperture, elongate-oval and widest at shoulder; canal slightly twisted.

Dimensions:—Length, 16 mm.; width of body whorl, 8 mm.

Type:—No. 11056, University of California. Locality 452, Tejon group, Cañada de las Uvas. On road in Grapevine Creek, S. W.  $\frac{1}{4}$  of S. E.  $\frac{1}{4}$ , Sec. 29, T. 10 N., R. 19 W. Coll., R. E. Dickerson.

### ***Exilia waringi*, new species**

Plate 9, figure 3

Shell elongate-fusiform; number of whorls unknown; penultimate whorl marked by a concave surface just above middle; lower half of whorl nearly flat and parallel to the axis; decoration of lower half of whorl consisting of five closely spaced spiral lines crossed by about twenty axial, sinuous, ribs which become obsolescent near base of whorl; upper half of whorl decorated by three spiral lines with alternating threads crossed by strong axial ribs; body-whorl with similar decoration; aperture elongate-oval; outer lip simple; inner lip marked by five or six very faint lirations (?).

This species resembles *Cordiera microptygma* Gabb but the axial ribs are different in number and the form of whorl is not convex. The markings on the inner lip of *E. waringi* are probably spiral lines only and not lirations characteristic of the genus *Cordiera*.

Dimensions:—Length of broken type, 12. mm.; width of body-whorl, 4 mm.

Type:—No. 328, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California, Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., Bruce Martin.

Named in honor of Mr. C. A. Waring of the California State Mining Bureau.

**Whitneya ficus Gabb**

*Whitneya ficus* Gabb, W. M., Geol. Calif. Palaeontology, vol. 1, p. 104, 1864.

Plate 9, figures 5a, 5b, 5c, 5d

This very characteristic Tejon species proves to be a form which varies greatly according to the stage of growth. The collection made by Mr. Martin at Cañada de las Uvas contains an excellent series which show growth stages very well. A young individual is marked by strong, quadrate axial ribs with flat interspaces of the same width while a youthful form is smooth on the back and has the quadrate ribs only on the body-whorl near the inner lip. A mature specimen is nearly smooth and is marked by faint spiral and axial threads only. Mature specimens differ somewhat in proportions. These may be sex differences.

**Murex packardi, new species**

Plate 9, figures 6a, 6b

Shell of medium size, fusiform, with five decidedly convex whorls; varices about three to each whorl but irregularly spaced; varices very characteristically ruffled; about twelve large, rugose, spiral lines cross the slightly sinuous varices; two well marked axial, nodose ribs found between the varices on body-whorl; canal nearly closed, narrow, twisted slightly to right.

Dimensions:—Length, 41 mm.; width of body-whorl, 25 mm.

Type:—No. 333, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 183. Coll., B. Martin.

Named in honor of Mr. Earl L. Packard whose collections at type locality of this species have greatly aided the writer.

**Urosalpinx hannibali, new species**

Plate 9, figures 7a, 7b

Shell fusiform with ten beautiful nearly continuous rounded axial ribs; whorls seven or eight in number, very convex and decorated by spiral lines which alternate in strength and by rounded ribs; aperture rounded, suddenly contracted

below into a short, narrow, twisted canal; inner lip slightly calloused.

Dimensions:—Length, 16 mm.; width of body whorl, 8 mm.

Type:—No. 334, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. This is Professor Weaver's University of Washington locality 1. Coll., B. Martin.

Named for Mr. Harold Hannibal.

***Sucula cohni*, new species**

Plate 10, figure 1

Shell of moderate size; whorls decorated by about twenty rounded nodes crossed by backward bowing sinuous growth lines which indicate the former central position of the sinus; a narrow collar just below a wavy impressed suture marking each whorl; space between collar and nodose central shoulder markedly concave; spiral ornamentation consisting of numerous spiral lines which alternate in size; aperture elongate-oval; outer lip simple; inner lip slightly calloused.

Dimensions:—Length of broken type, 22 mm.; width of body-whorl, 8 mm.

Type:—No. 336, Cal. Acad. Sci. Locality 245, along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about 35 miles south of Bakersfield, California. Coll., B. Martin.

Named in honor of Mr. Roy Cohn who accompanied the writer to the type locality.

***Surcula (Surculites) sinuata* Gabb**

Plate 10, figures 2a, 2b, 2c

*Conus sinuatus* Gabb, W. M., Geology of California, Palaeontology, vol. 1, p. 123, 1864.

*Surcula (Surculites) sinuata* Gabb, W. M., Geology of California, Palaeontology, vol. 2, pp. 150-151, 1869.

This species is another form which varies with its growth stages. The young individuals are slenderer and are marked by medium sized spiral lines which become obsolete in mature forms.

**Drillia ornata**, new species

Plate 10, figure 3

Shell elongated, fusiform; spire high; whorls eight, angular; suture distinct; surface marked by ten to twelve large rounded oblique ribs most prominent at shoulder and below, becoming obsolete above; these are crossed by numerous prominent, spiral ribs with very narrow interspaces; sinus located very slightly above shoulder; aperture elongate, wide above, narrow below.

This shell resembles *D. raricostata* Gabb in shape but its axial ribs are more numerous and its whorls are more angular.

Dimensions:—Length, 17 mm.; width of body-whorl, 6 mm.

Type:—No. 337, Cal. Acad. Sci. Locality, 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. Coll., B. Martin.

**Turris pulchra**, new species

Plate 10, figures 4a, 4b

Shell fusiform with nine whorls; first four turbo-form, smooth; others sharply angulated by a shoulder a third of whorl below suture; decorated by twelve to fourteen sub-equal spiral lines which are slightly nodose where the fine sinuous axial ribs cross them; a beaded sutural collar occurring just below indistinct suture; aperture elongate with greatest width above, narrowing below into a slender canal; outer lip, thin; inner lip but slightly calloused.

Dimensions:—Length, 20 mm.; width of body-whorl, 6.5 mm.

Type:—No. 338, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. Coll., B. Martin.

**Surcula uvasana**, new species

Plate 10, figure 10

Shell, spindle-shaped with seven or eight whorls; decoration of the penultimate whorl consisting of a tabulate, nodose, medial carina, two nodose spiral lines of equal strength below

the carina, a nodose spiral thread on the tabulation above the shoulder and a nodose spiral line above the carina and close to the wavy suture; body-whorl marked by a strong carina at the shoulder and by a nodose spiral line in its middle where a second angulation occurs; twelve to fifteen nodose spiral lines occurring in addition to these two prominent lines described above; mouth oval; outer lip simple. This species is easily recognizable on account of its nodose spiral lines.

Dimensions:—Length of broken type specimen, 22 mm.; width of body-whorl, 7 mm.

Type:—No. 11057, University of California. Locality 458, Tejon Quadrangle, Tejon group, west side of Grapevine Creek, elevation 2050 feet, about  $4\frac{1}{2}$  miles S.  $6^{\circ}$  W. of 1085 B. M. about 400 feet (stratigraphic) above Basement Complex-Tejon Contact. Coll., R. E. Dickerson.

Named for its occurrence at the type locality of the Tejon on the Cañada de las Uvas.

### *Surcula io* (Gabb)

Plate 10, figure 11

*Fasciolaria io* Gabb, W. M., Geology of California, Palaeontology, vol. 1, p. 101, 1864.

This species was described as a *Fasciolaria* but careful examination fails to reveal any traces of plications and the position of the sinus is that of the genus *Surcula*.

This species belongs to the same general section of *Surcula* as *Surcula washingtoniana* (Weaver), (See Plate 10, figures 7a, 7b), but details of sculpture readily separate them.

### *Fusus washingtoniana* Weaver

*Fusus washingtoniana* Weaver, C. E., Wash. Geol. Surv. Bull. 15, p. 50, 1912.

Plate 9, figure 8

The beautiful specimen figured is larger and more nearly perfect than Weaver's type. It is very close to *Fusus merriami* Dickerson (ms.) of *Siphonalia sutterensis* Zone of the Marysville Buttes, but it differs somewhat in proportion and details of sculpture.

***Fusus willisi*, new species**

Plate 11, figures 1a, 1b

Shell elongate-conic; number of whorls unknown; whorls convex, decorated by twelve nearly continuous axial ribs made nodose by intersection of eight strong, spiral lines; suture wavy, distinct; aperture elongate-oval; outer lip simple; inner lip slightly incrustated.

Dimensions:—Length of broken type, 17.5 mm.; width of body-whorl, 7 mm.

Type:—No. 345, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and a half miles east of Vader, Washington. Coll., B. Martin.

Named in honor of Mr. Bailey Willis of the United States Geological Survey whose excellent detailed mapping in Washington has greatly aided workers in this field.

***Fasciolaria buwaldana*, new species**

Plate 11, figures 2a, 2b

Shell, fusiform with probably eight convex whorls; whorls slightly shouldered a short distance below a wavy, impressed suture; spire-whorls decorated by nine axial ribs crossed by seven, very wavy, spiral lines of equal size; body whorl decoration similar except that the spiral lines over the widest part of whorl alternate in strength; aperture elongate-oval, widest in middle, narrowing below into a slightly sinuous canal of medium length. This species also occurs at Cal. Acad. Sci. Locality 245.

Dimensions:—Length, 19.5 mm.; width of body-whorl, 7.5 mm.

Type:—No. 346, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. Coll., B. Martin.

Named for Mr. John P. Buwalda who spent a season collecting in the Washington formations for the California Academy of Sciences.

**Fasciolaria sinuata** Gabb

*Fasciolaria sinuata* Gabb, W. M., Geology of California, Palaeontology, vol. 1, p. 101, 1864.

Plate 11, figures 3a, 3b

This species is slightly more robust in young individuals than in older forms. The characteristic lirations in this species can only be discerned as a rule by breaking a specimen so that the spire portion of the columella can be examined, as the lirations on the outer lip are lacking. This form is very abundant at the type locality of the Tejon.

**Conus californiana** (Conrad)

Plate 11, figure 6

*Volutilithes californiana* Conrad, Pacific R. R. Report, vol. 5, p. 322, 1855.

Not *Conus remondii* Gabb, Rept. Geol. Surv. of California, Palaeontology, vol. 2, p. 122, 1869.

The specimen figured is without much doubt Conrad's form. Gabb described another *Conus* as *C. remondii* and placed this species in synonymy. Gabb's collections from the type Tejon were evidently not as exhaustive as he thought as he failed to find other forms which Conrad described.

This species has fewer nodes than *C. remondii* (See Plate 11, figure 7) and its spire height is greater. It differs from *C. cowlitzensis* Weaver (See Plate 11, figure 8) in having a shorter spire and a lesser number of nodes. The space between the suture and shoulder of this form is nearly flat while the corresponding space on *C. cowlitzensis* is decidedly concave.

**Conus weaveri**, new species

Plate 11, figure 10

Shell small, wide, short, with six whorls; decoration consisting of numerous spiral lines most prominent on lower part of body-whorl.

This species is easily distinguished from *C. hornii* (See Plate 11, figures 9a, 9b, 9c) by its greater breadth and by its marked spiral lines. Its lack of nodes renders it easily separable from *C. cowlitzensis*, *C. californiana*, and *C. remondii*.

Dimensions:—Length, 15.5; width of body-whorl, 9.5 mm.

Type:—No. 356, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. Coll., B. Martin.

Named in honor of Professor C. E. Weaver.

**Mitra uvasana**, new species

Plate 11, figures 13a, 13b

Shell of medium size; elongate, spindle-shaped, the spire being a third the total length of shell; spire-whorls, probably eight or nine in number, flat sided, increasing slowly in size; suture impressed; body-whorl slightly convex with constriction three-fourths of whorl-length below suture; shell decorated by many fine ribbon-like spiral ribs. This species differs from *Mitra washingtoniana* Weaver and *M. simplicissima* Cooper in the greater length of spire and its marked ribbing.

Dimensions:—Length, 29 mm.; width of body-whorl, 11 mm.

Type:—No. 358, Cal. Acad. Sci. Locality 245, Tejon Quadrangle, Tejon group. Along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about 35 miles south of Bakersfield, Cal. Coll., B. Martin.

**Voluta slevini**, new species

Plate 11, figure 16

Shell fusiform, with very rounded body-whorl; number of whorls unknown; decoration on body-whorl consisting of ten to fifteen strong spiral lines crossed by twenty axial ribs of equal strength; rounded nodes found at crossing of two sets of decoration; aperture oval; outer lip thin; inner lip bearing at least five plaits of equal size.

Dimensions:—Width of body-whorl, 9 mm.

Type:—No. 362, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California, Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., B. Martin.



Named for Mr. Joseph R. Slevin, assistant curator of herpetology, Cal. Academy of Sciences, who assisted Mr. Bruce Martin in collecting at the type locality.

***Voluta martini*, new species**

Plate 11, figures 14a, 14b.

Shell large, nodose; number of whorls unknown; penultimate whorl decorated by eight or nine sharply pointed nodes which are situated on a shoulder two-thirds of the whorl-length below a wavy irregular suture; space between these nodes and the suture of the preceding whorl smooth and slightly concave; body-whorl elongate with shoulder situated about one-fourth of whorl-length below suture; shoulder decorated by eight nodes similar to those of the penultimate whorl; body-whorl decorated by growth lines only; mouth elongate, oval; outer lip simple; inner lip marked by four strong folds, the anterior fold being the strongest; canal short, twisted. This species is easily distinguished from *V. lawsoni* Dickerson by its more elongate form. Two specimens were found by Mr. Martin.

Dimensions:—Length of broken specimen, 38 mm.; width of body-whorl, 20 mm.

Type:—No. 360, Cal. Acad. Sci. Locality No. 244, in the east bank of Live Oak Creek about three-quarters of a mile from its mouth. This locality is about three miles due east of the mouth of Grapevine Canyon, Tejon group, vicinity of Type Locality. Coll., Bruce Martin, for whom the specimen is named.

***Voluta*, species**

Plate 11, figure 15

An immature form which is apparently new was found at Cal. Acad. Sci. Locality 244. The whorls of this form are decorated by twenty sharp axial ribs crossed by equally spaced spiral threads. Four very prominent plaits are formed on the inner lip. Length of specimen is 7 mm.



## EXPLANATION OF PLATE 1

Fig. 1. *Leda gabbi* Conrad,  $\times 3$ . Figured specimen is from University of California Locality 672.

Fig. 2a. *Leda uvasana*, new species,  $\times 2$ . Type.

Fig. 2b. *Leda uvasana*, new species,  $\times 2$ .

Fig. 3. *Leda vaderensis*, new species,  $\times 2$ . Type.

Fig. 4. *Arca hornii* Gabb,  $\times 2$ . A common species in the Tejon group. Figured specimen is from University of California Locality 672.

Fig. 5a. *Glycimeris ruckmani*, new species,  $\times 1$ . Type.

Fig. 5b. *Glycimeris ruckmani*, new species,  $\times 1$ .

Fig. 6. *Glycimeris cor* Gabb,  $\times 1$ . This is an unusually large specimen of this species and is introduced for comparison with *G. ruckmani*, new species.

Fig. 7. *Spondylus carlosensis* Anderson,  $\times 1$ . This is one of the few species from basal beds of the Tejon group, type locality.

Fig. 8. *Crassatellites grandis* Gabb,  $\times 1$ . This species is also found in the Martinez group, lower Eocene. It is very abundant at some Tejon localities and is one of the few large pelecypods in the Tejon fauna.



5a



5b



6



4



2a



3



2b



8



1



7





## EXPLANATION OF PLATE 2

Fig. 1a. *Crassatellites grandis* Gabb,  $\times 1$ . The specimen figured is from California Acad. Sci. Locality 183.

Fig. 1b. *Crassatellites grandis* Gabb,  $\times 1$ . View showing hinge of specimen figured as Fig. 1a.

Fig. 2. *Crassatellites uvasana* Gabb,  $\times 2$ . Figured specimen from Cal. Acad. Sci. Locality 245, is a common Tejon species.

Fig. 3a. *Cardium breweri* Gabb,  $\times 2$ . This specimen from Cal. Acad. Sci. Locality 183 is slightly longer than the species found at Cañada de las Uvas. It may prove to be a subspecies.

Fig. 3b. *Cardium breweri* Gabb,  $\times 2$ . Hinge view of specimen figured as Fig. 3a.

Fig. 4. *Lucina cumulata* Gabb,  $\times 3$ . This species probably belongs to the genus *Divaricella* but since its hinge is unknown it is thought best to let the old reference remain until better material is found.



3b



1a



3a



2



1b



4







## EXPLANATION OF PLATE 3

Fig. 1a. *Macrocallista conradiana* (Gabb),  $\times 2$ . This species was described as *Tapes conradiana*. It is a very common form throughout the Tejon group of California. The figured specimen is from Cal. Acad. Sci. Locality 244.

Fig. 1b. *Macrocallista conradiana* (Gabb),  $\times 2$ . Umbone view of specimen from Cal. Acad. Sci. Locality 244.

Fig. 1c. *Macrocallista conradiana* Gabb,  $\times 1$ . Hinge view of large specimen from Locality 244.

Fig. 2a. *Meretrix tejonensis*, n. nom.,  $\times 1$ .

Fig. 2b. *Meretrix tejonensis*, n. nom.,  $\times 2$ . This species was identified and redescribed by Gabb as *Meretrix uvasana* Conrad but he really had not obtained Conrad's cotype.

Fig. 3a. *Meretrix uvasana* Conrad,  $\times 1$ . Figured specimen is from Cal. Acad. Sci. Locality 244.

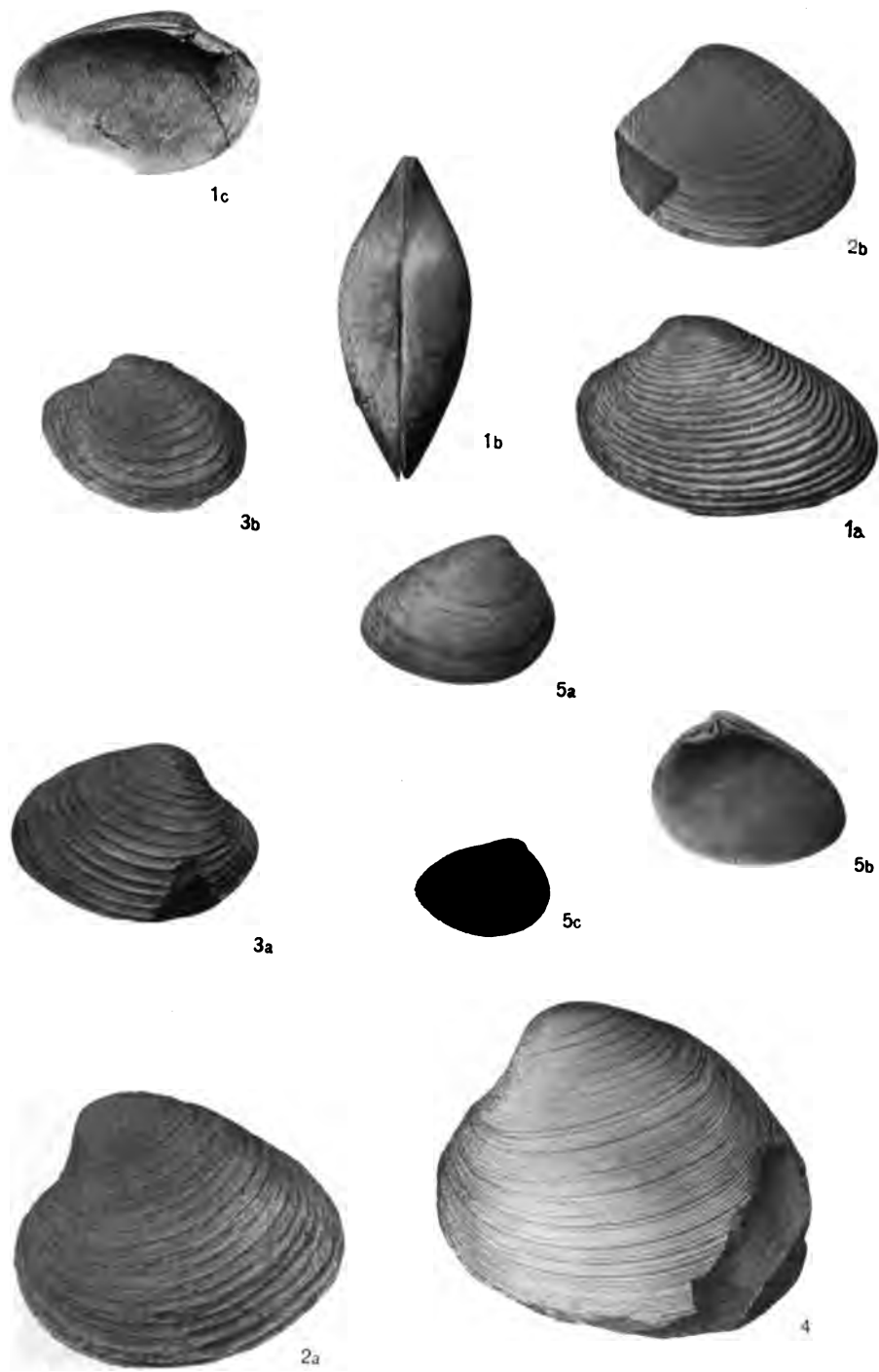
Fig. 3b. *Meretrix uvasana* Conrad,  $\times 1$ .

Fig. 4. *Meretrix ovalis* Gabb,  $\times 1$ . From Cal. Acad. Sci. Locality 245.

Fig. 5a. *Macrocallista vaderensis*, new species,  $\times 1$ . Type. From Cal. Acad. Sci. Locality 183.

Fig. 5b. *Macrocallista vaderensis*, new species,  $\times 1$ . View showing interior of type specimen.

Fig. 5c. *Macrocallista vaderensis*, new species,  $\times 1$ . View of interior of a small left valve from Cal. Acad. Sci. Locality 183.

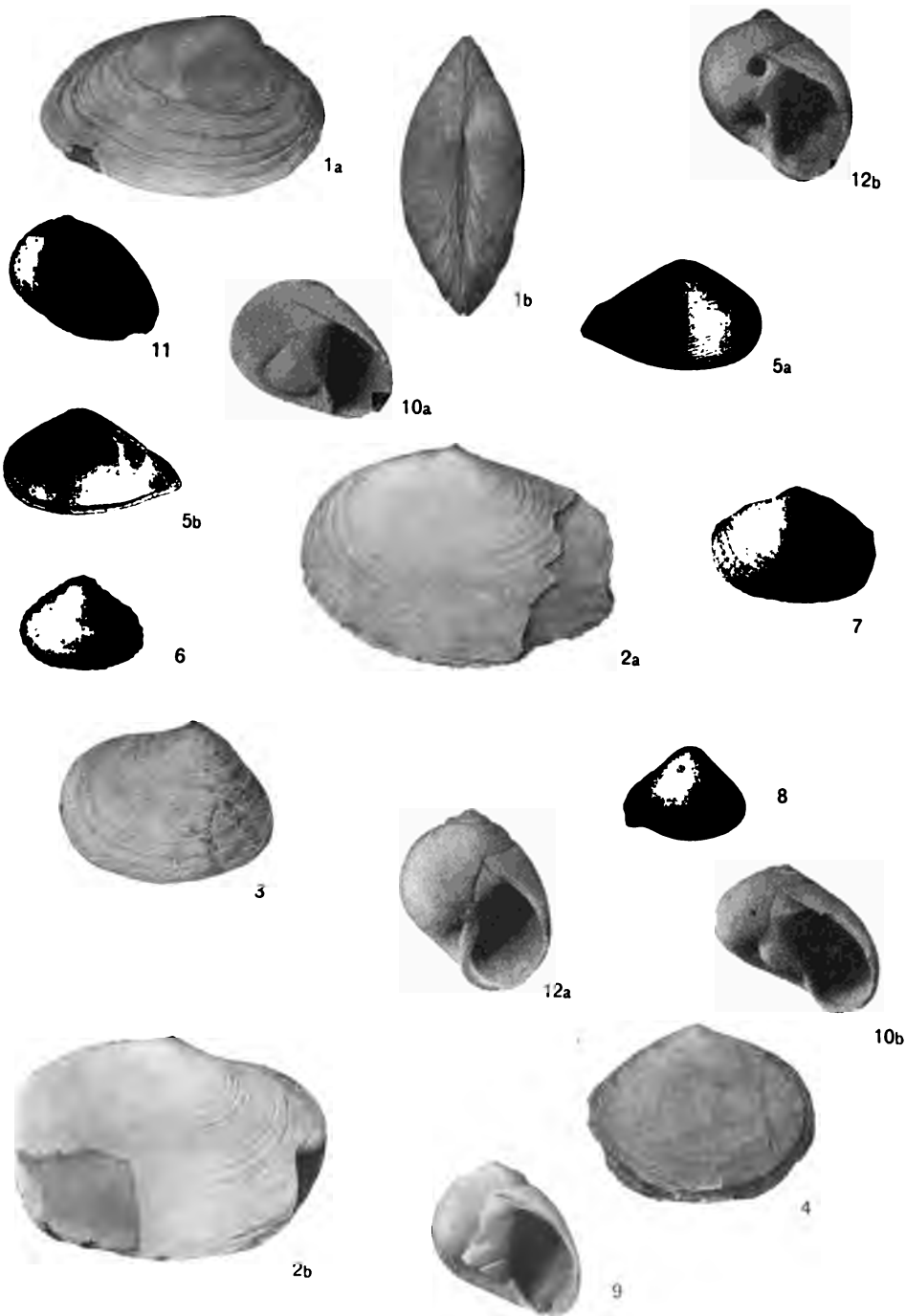






## EXPLANATION OF PLATE 4

- Fig. 1a. *Macrocallista* (?) *andersoni*, new species,  $\times 1$ . Type.  
Fig. 1b. *Macrocallista andersoni*, new species,  $\times 1$ . Umbone view of species from Cal. Acad. Sci. Locality 183, Cowlitz phase, Washington.  
Fig. 2a. *Tellina howardi*, new species,  $\times 1$ . Type.  
Fig. 2b. *Tellina howardi*, new species,  $\times 1$ .  
Fig. 3. *Tellina californica* Gabb,  $\times 2$ .  
Fig. 4. *Semele diaboli*, new species,  $\times 1$ . Type.  
Fig. 5a. *Corbula hornii* Gabb,  $\times 2$ . This species is introduced for comparison with *Corbula harrisi*, new species, and *Corbula uvasana*, new species.  
Fig. 5b. *Corbula hornii* Gabb,  $\times 2$ . Interior of same specimen figured as Fig. 5a.  
Fig. 6. *Corbula harrisi*, new species,  $\times 2$ . Type.  
Fig. 7. *Corbula uvasana*, new species,  $\times 2$ . Type.  
Fig. 8. *Corbula parilis* Gabb,  $\times 2$ . View of specimen from Marysville Buttes Tejon.  
Fig. 9. *Neverita secta* Gabb,  $\times 1$ . From Cal. Acad. Sci. Locality 182.  
Fig. 10a. *Neverita weaveri*, new species,  $\times 2$ . Type.  
Fig. 10b. *Neverita weaveri*, new species,  $\times 3$ . Cotype showing young form with small umbilicus.  
Fig. 11. *Lunatia hornii* Gabb,  $\times 1$ . Specimen from Cal. Acad. Sci. Locality 245.  
Fig. 12a. *Lunatia cowlitzensis*, new species,  $\times 1$ . Type.  
Fig. 12b. *Lunatia cowlitzensis*, new species,  $\times 1$ . Cotype showing mouth view of broad variety.









## EXPLANATION OF PLATE 5

Fig. 1a. *Turritella uvasana* Conrad,  $\times 2$ . Mouth view of a beautiful specimen from Univ. of California Locality 672.

Fig. 1b. *Turritella uvasana* Conrad,  $\times 1$ . Cal. Acad. Sci. Locality 244.

Fig. 1c. *Turritella uvasana* Conrad,  $\times 1$ . Back view showing variation in strength of spire ribbing.

Fig. 2. *Turritella uvasana bicarinata*, new variety,  $\times 1$ . View of type showing two well marked carinae, Cal. Acad. Sci. Locality 244.

Fig. 3. *Turritella uvasana* Conrad,  $\times 1$ . This specimen from Locality 244 appears to be intermediate between the specimen figured as Fig. 2a and specimen in Fig. 1c.

Fig. 4. *Turritella uvasana tricarinata*, new variety,  $\times 1$ . Type.

Fig. 5a. *Naticina obliqua* Gabb,  $\times 2$ . Cal. Acad. Sci. Locality 182.

Fig. 5b. *Naticina obliqua* Gabb,  $\times 2$ . Mouth view of same specimen figured as Fig. 5a.

Fig. 6a. *Crepidula*, new species,  $\times 2$ .

Fig. 6b. *Crepidula*, new species,  $\times 2$ . Back view of same specimen, from Cal. Acad. Sci. Locality 182.

Fig. 7a. *Nerita cowlitzensis*, new species,  $\times 2$ . Mouth view of type.

Fig. 7b. *Nerita cowlitzensis*, new species,  $\times 2$ . Back view of type.

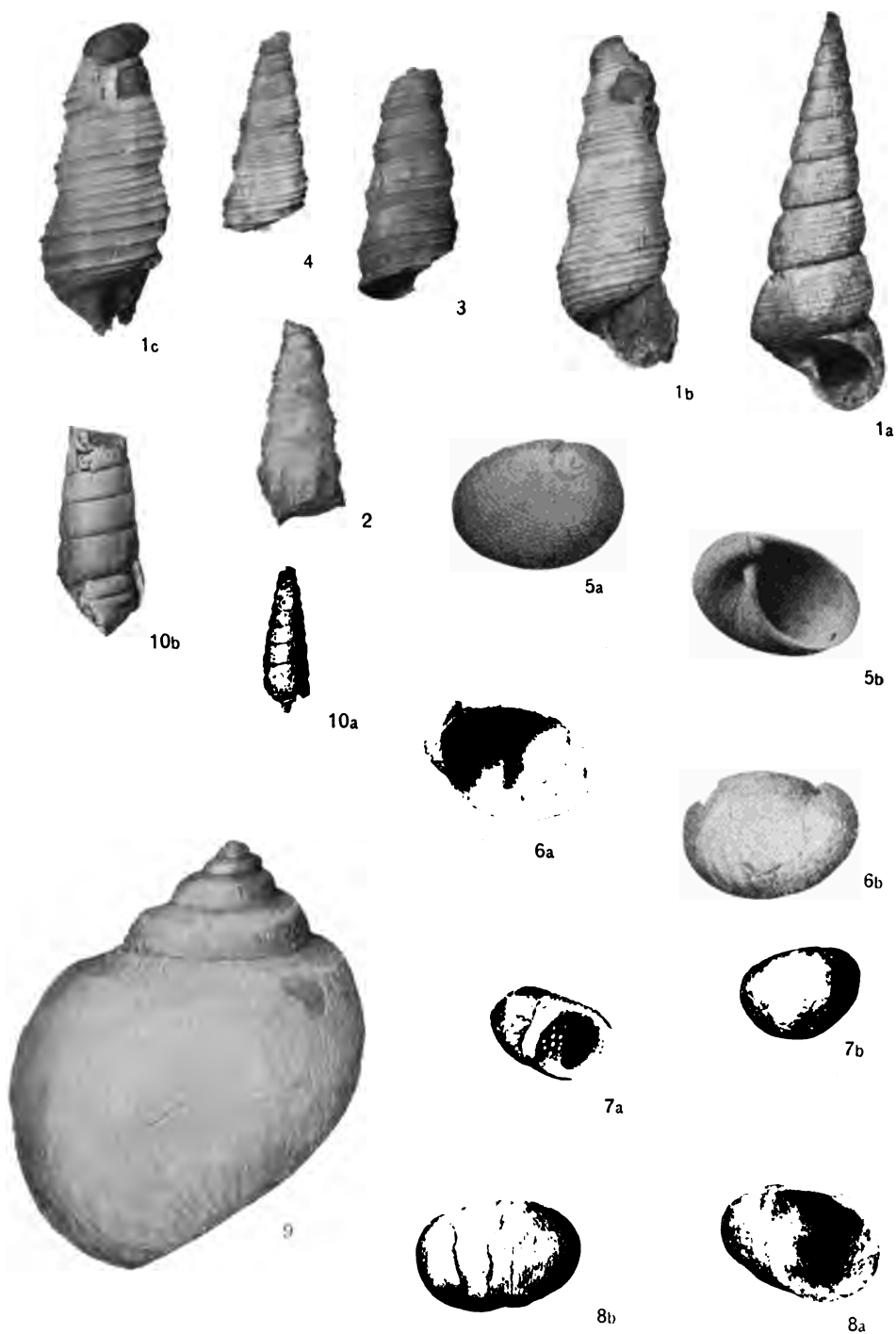
Fig. 8a. *Neritina martini*, new species,  $\times 1$ . Type.

Fig. 8b. *Neritina martini*, new species,  $\times 1$ . Back view of type.

Fig. 9. *Amauropsis alveata* (Conrad),  $\times 1$ . Back view of an unusually large specimen of this characteristic Tejon species.

Fig. 10a. *Odostomia*, new species,  $\times 3$ . Specimen from Cal. Acad. Sci. Locality 183.

Fig. 10b. *Odostomia*, new species,  $\times 3$ . View of a larger specimen.

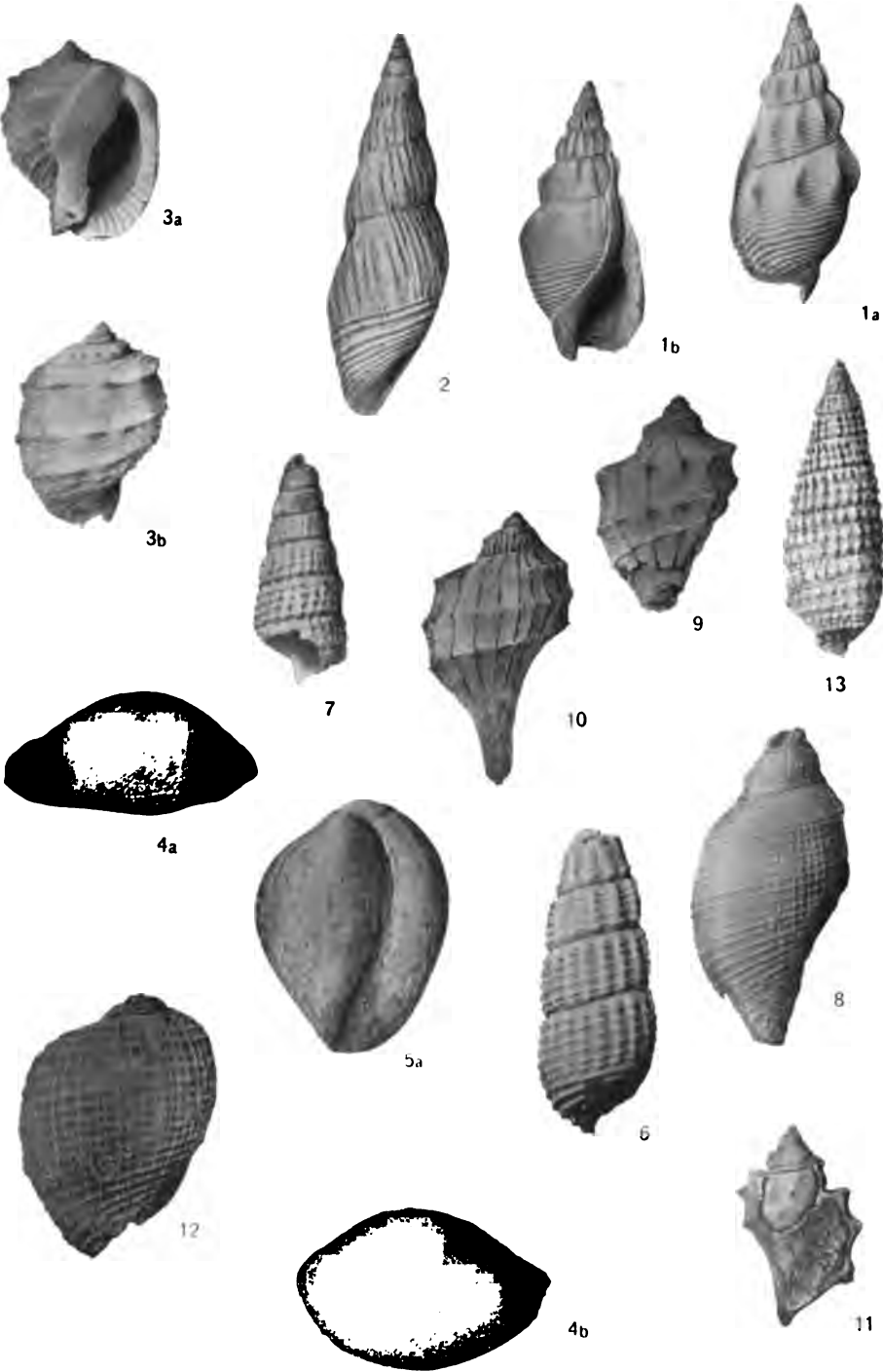






## EXPLANATION OF PLATE 6

- Fig. 1a. *Rimella simplex* Gabb,  $\times 1$ . Cal. Acad. Sci. Locality 182.  
Fig. 1b. *Rimella simplex* Gabb,  $\times 1$ . Mouth view.  
Fig. 2. *Rimella elongata* (Weaver),  $\times 2$ .  
Fig. 3a. *Galeodea tuberculata* (Gabb),  $\times 1$ . Mouth view of specimen from Cal. Acad. Sci. Locality 182.  
Fig. 3b. *Galeodea tuberculata* (Gabb),  $\times 1$ . Back view of same specimen.  
Fig. 4a. *Cypræa bayerquei* Gabb,  $\times 2$ . Side view of specimen from Univ. of Cal. Locality 452.  
Fig. 4b. *Cypræa bayerquei*,  $\times 2$ . Back view of specimen from Univ. of Cal. Locality 452.  
Fig. 5. *Cypræa mathewsonii* Gabb,  $\times 2$ . Mouth view of specimen from Cal. Acad. Sci. Locality 245.  
Fig. 6. *Melania packardi*, new species,  $\times 2$ . Type.  
Fig. 7. *Melania vaderensis*, new species,  $\times 2$ . Type.  
Fig. 8. *Ficopsis remondii* Gabb,  $\times 2$ . This species is very close to *Pyrula penita* Conrad of the Claiborne Eocene. Specimen figured is from Cal. Acad. Sci. Locality 244.  
Fig. 9. *Ficopsis hornii* Gabb,  $\times 1$ . Cal. Acad. Sci. Locality 244.  
Fig. 10. *Ficopsis cowlitzensis* (Weaver),  $\times 1$ . The cotype figured is from Cal. Acad. Sci. Locality 182. This form is very near *F. hornii* Gabb as will be seen upon comparing figures.  
Fig. 11. *Ficopsis cooperi* Gabb,  $\times 1$ . Cotype from Rose Canyon, San Diego County, Cal.  
Fig. 12. *Ficus mamillatus* Gabb,  $\times 2$ . This specimen from Cal. Acad. Sci. Locality 244 was placed by Conrad in the genus *Ficopsis*.  
Fig. 13. *Triforis washingtoniana*, new species,  $\times 3$ .









## EXPLANATION OF PLATE 7

Fig. 1a. *Pseudoliva inornata*, new species,  $\times 1$ . Type from Univ. of Cal. Locality 458.

Fig. 1b. *Pseudoliva inornata*, new species,  $\times 2$ . Cal. Acad. Sci. Locality 183.

Fig. 1c. *Pseudoliva inornata*, new species,  $\times 2$ . Mouth view of specimen figured as Fig. 1a.

Fig. 2. *Pseudoliva tejonensis*, new species,  $\times 1$ . Type from Cal. Acad. Sci. Locality 245.

Fig. 3a. *Pseudoliva volutæformis* Gabb,  $\times 1$ . This is a mature specimen from Cal. Acad. Sci. Locality 244.

Fig. 3b. *Pseudoliva volutæformis* Gabb,  $\times 2$ . This specimen is a young individual from Cal. Acad. Sci. Locality 244.

Fig. 4. *Bursa washingtoniana* (Weaver),  $\times 1$ .

Fig. 5a. *Nyctilochus kewi*, new species,  $\times 1$ . Mouth view of type.

Fig. 5b. *Nyctilochus kewi*, new species,  $\times 1$ . Back view of type.

Fig. 6. *Bursa washingtoniana* (Weaver),  $\times 1$ . Cotype from Cal. Acad. Sci. Locality 182.

Fig. 7. *Nyctilochus californicus* Gabb,  $\times 1$ . The specimen figured is far larger than Gabb's type. Univ. of Cal. Locality 458.

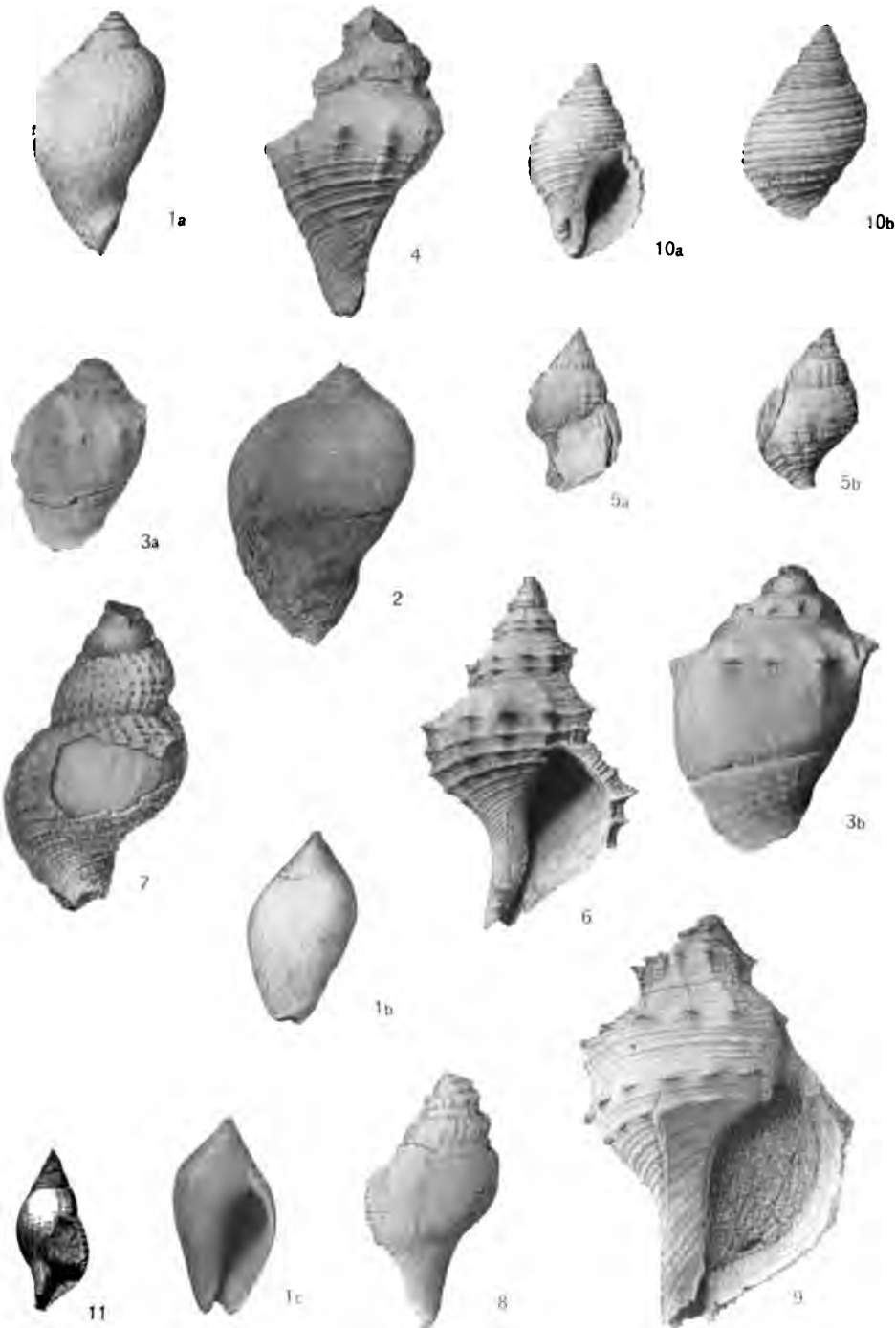
Fig. 8. *Nyctilochus hornii* (Gabb),  $\times 2$ . Cal. Acad. Sci. Locality 244.

Fig. 9. *Nyctilochus washingtoniana* (Weaver),  $\times 1$ . This specimen was described as *Cassidaria washingtoniana*, the canal being absent from the type specimen. Cotype from Cal. Acad. Sci. Locality 182.

Fig. 10a. *Cantharus perrini*, new species,  $\times 2$ . Mouth view of type.

Fig. 10b. *Cantharus perrini*, new species,  $\times 2$ . Back view of type.

Fig. 11. *Chrysodomus ruckmani*, new species,  $\times 1$ . Aperture view of type. Univ. of Cal. Locality 452.

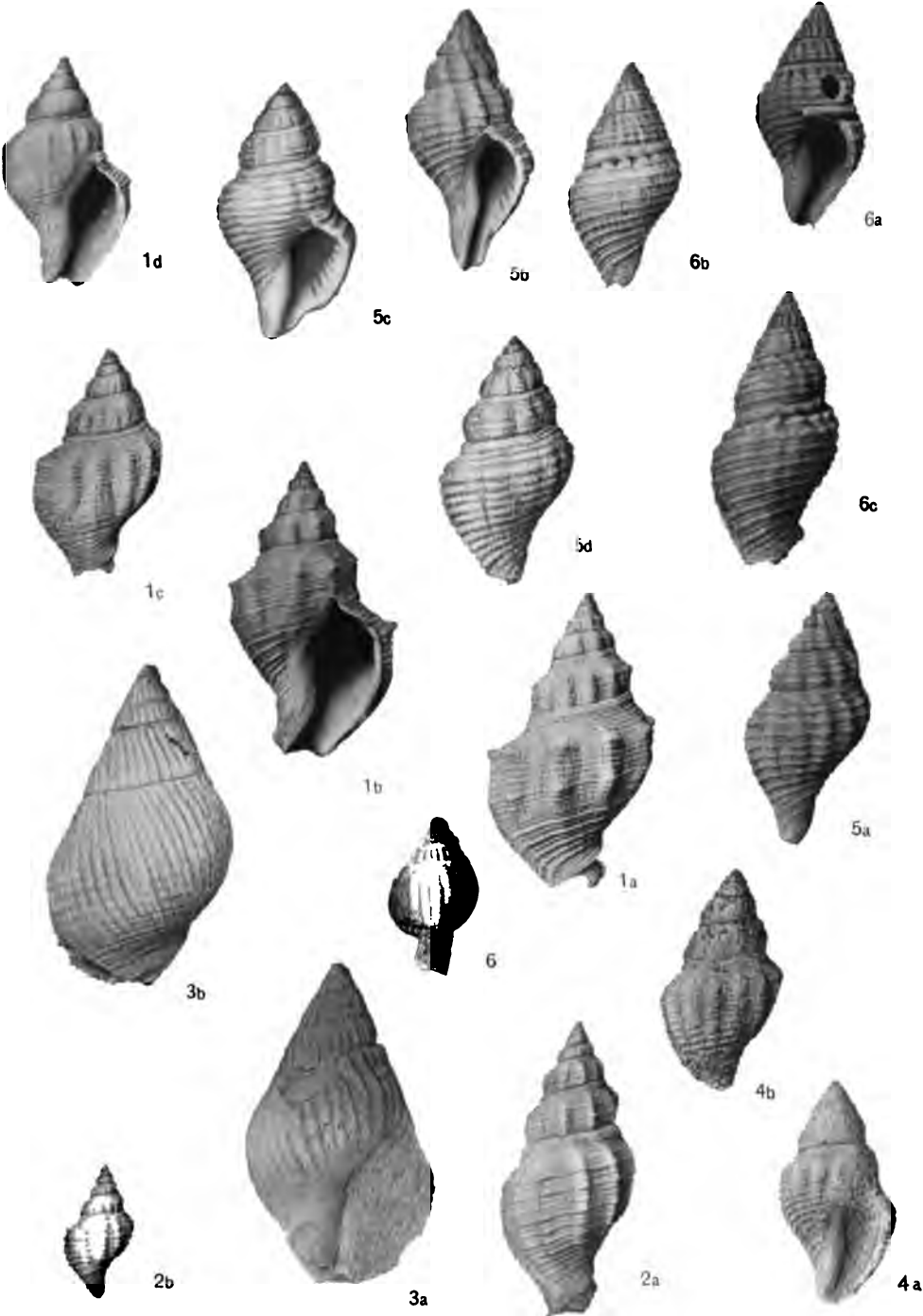






## EXPLANATION OF PLATE 8

- Fig. 1a. *Siphonalia bicarinata*, new species,  $\times 2$ . Type.  
Fig. 1b. *Siphonalia bicarinata*, new species,  $\times 2$ . Aperture view of type.  
Fig. 1c. *Siphonalia bicarinata*, new species,  $\times 2$ . Back view of young individual, a cotype.  
Fig. 1d. *Siphonalia bicarinata*, new species,  $\times 2$ . Aperture view of specimen figured at Fig. 1c.  
Fig. 2a. *Hemifusus sopenahensis* Weaver,  $\times 1$ . Cotype.  
Fig. 2b. *Hemifusus sopenahensis* Weaver,  $\times 1$ . Cotype. This specimen, a young individual, suggests the genus *Nystilochus* decidedly. It differs in certain details of form from mature specimens.  
Fig. 3a. *Molopophorus tejonensis*, new species,  $\times 2$ . Aperture view of type.  
Fig. 3b. *Molopophorus tejonensis*, new species,  $\times 2$ . Back view of type.  
Fig. 4a. *Hemifusus volutæformis*, new species,  $\times 2$ . Aperture view of type.  
Fig. 4b. *Hemifusus volutæformis*, new species,  $\times 2$ . Back view of type.  
Fig. 5a. *Urosalpinx tejonensis* (Weaver),  $\times 2$ . Cotype from Cal. Acad. Sci. Locality 182. This was described by Weaver as *Hemifusus tejonensis* but better material shows it to belong in the genus *Urosalpinx*.  
Fig. 5b. *Urosalpinx tejonensis* (Weaver),  $\times 2$ . Aperture view of cotype.  
Fig. 5c. *Urosalpinx tejonensis* (Weaver),  $\times 2$ . Aperture view of a short variety.  
Fig. 5d. *Urosalpinx tejonensis* (Weaver),  $\times 2$ . Back view of specimen figured as 5c.  
Fig. 6a. *Amphissa eocenica* (Weaver),  $\times 2$ . Cotype.  
Fig. 6b. *Amphissa eocenica* (Weaver),  $\times 2$ .  
Fig. 6c. *Amphissa eocenica* (Weaver),  $\times 2$ . Cotype illustrating change in proportions in older individuals.  
Fig. 7. *Molopophorus striata* Gabb,  $\times 3$ .









## EXPLANATION OF PLATE 9

- Fig. 1. *Exilia diaboli* (Gabb),  $\times 2$ . University of Cal. Locality 452.  
Fig. 2a. *Exilia perkinsiana* (Cooper),  $\times 2$ . Back view of species from Cal. Acad. Sci. Locality 183.  
Fig. 2b. *Exilia perkinsiana* (Cooper),  $\times 2$ . View showing canal and body whorl of a specimen from Cal. Acad. Sci. Locality 183.  
Fig. 3. *Exilia waringi*, new species,  $\times 3$ . Type. Cal. Acad. Sci. Locality 244.  
Fig. 4. *Nyctilochus cowlitzensis* (Weaver),  $\times 1$ . Cotype. Cal. Acad. Sci. Locality 182.  
Fig. 5a. *Whitneya ficus* Gabb,  $\times 2$ . Back view of a young individual showing strong axial ribs.  
Fig. 5b. *Whitneya ficus* Gabb,  $\times 2$ . Mouth view of second member of a series illustrating the axial ribs in the vicinity of the inner lip. The rest of the body whorl is smooth.  
Fig. 5c. *Whitneya ficus* Gabb,  $\times 1$ . View showing a mature individual. This series showing stages of growth was collected at Cal. Acad. Sci. Locality 245.  
Fig. 5d. *Whitneya ficus* Gabb,  $\times 1$ .  
Fig. 6a. *Murex packardi*, new species,  $\times 1$ . Aperture view of type.  
Fig. 6b. *Murex packardi*, new species,  $\times 1$ . Back view of type.  
Fig. 7a. *Urosalpinx hannibali*, new species,  $\times 2$ . Aperture view of type.  
Fig. 7b. *Urosalpinx hannibali*, new species,  $\times 2$ . Back view of type.  
Fig. 8. *Fusus washingtoniana* Weaver,  $\times 1$ .  
Fig. 9. *Exilia dickersoni* (Weaver),  $\times 1$ .



5d



5c



6a



7a



5b



6b



7b



4



5a



9



2b



8



3



1



2a





## EXPLANATION OF PLATE 10

- Fig. 1. *Surcula cohni*, new species,  $\times 2$ . Type.
- Fig. 2a. *Surcula* (*Surculites*) *sinuata* Gabb,  $\times 1$ . Mouth view of half grown individual which is marked by spiral lines. Univ. of Cal. Locality 458.
- Fig. 2b. *Surcula* (*Surculites*) *sinuata* Gabb,  $\times 1$ . Back view of specimen figured as Fig. 2a.
- Fig. 2c. *Surcula* (*Surculites*) *sinuata* Gabb,  $\times 1$ . Back view of mature individual showing almost complete absence of decoration. Univ. of Cal. Locality 458.
- Fig. 3. *Drillia ornata*, new species,  $\times 2$ . Type specimen.
- Fig. 4a. *Turris pulchra*, new species,  $\times 2$ . Mouth view of type specimen.
- Fig. 4b. *Turris pulchra*, new species,  $\times 2$ . Back view of type.
- Fig. 5. *Turris*, new species,  $\times 2$ .
- Fig. 6. *Turris monolifera* Cooper, new species,  $\times 2$ . Specimen is an unusually large one from Cal. Acad. Sci. Locality 183.
- Fig. 7a. *Surcula washingtoniana* (Weaver),  $\times 1$ . Mouth view of cotype.
- Fig. 7b. *Surcula washingtoniana* (Weaver),  $\times 1$ . Back view of cotype.
- Fig. 8. *Surcula cowlitzensis* Weaver,  $\times 1$ . Back view of cotype from Cal. Acad. Sci. Locality 182. This is one of the most beautiful forms from the Tejon Eocene. It is abundant in Washington and at the type locality of the Tejon.
- Fig. 9. *Turris* cf. *monolifera* Cooper,  $\times 2$ . Specimen from Cal. Acad. Sci. Locality 183, a young individual.
- Fig. 10. *Surcula uvasana*, new species. Back view of type.
- Fig. 11. *Surcula io* (Gabb),  $\times 1$ . This form was described as a *Fasciolaria* but careful examination fails to reveal any traces of plications and the position of the sinus is such as found in the genus *Surcula*. Cal. Acad. Sci. Locality 244.



1



2a



3



4a



5



6



7a



7b



9



2b



8



4b



10



2c



11

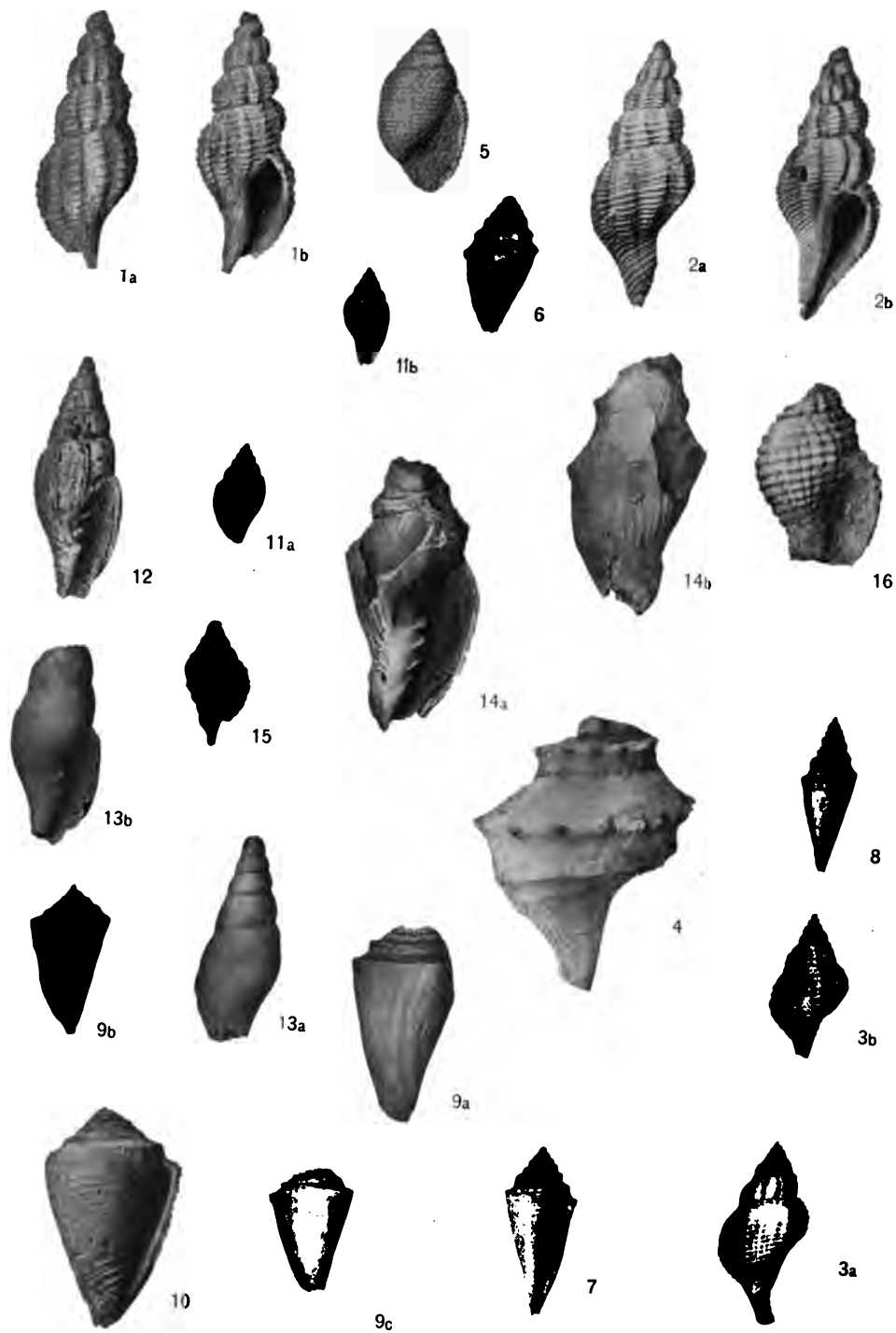






## EXPLANATION OF PLATE 11

- Fig. 1a. *Fusus willisi*, new species,  $\times 2$ . Back view of type.  
Fig. 1b. *Fusus willisi*, new species,  $\times 2$ . Mouth view of type.  
Fig. 2a. *Fasciolaria buwaldana*, new species,  $\times 2$ . Back view of type.  
Fig. 2b. *Fasciolaria buwaldana*, new species,  $\times 2$ . Aperture view of type.  
Fig. 3a. *Fasciolaria sinuata* Gabb,  $\times 1$ . Back view of cotype from Cal. Acad. Sci. Locality 245. The characteristic lirations in this species can only be discerned as a rule by breaking a specimen so that the spire portion of the columella can be examined.  
Fig. 3b. *Fasciolaria sinuata* Gabb,  $\times 1$ .  
Fig. 4. *Perissolax blakei* (Conrad),  $\times 1$ . Cotype from Cal. Acad. Sci. Locality 244.  
Fig. 5. *Actæon*, new species,  $\times 3$ . Cal. Acad. Sci. Locality 244.  
Fig. 6. *Conus californiana* (Conrad),  $\times 1$ . Univ. of Cal. Locality 456.  
Fig. 7. *Conus remondii* Gabb,  $\times 1$ . Cal. Acad. Sci. Locality 182.  
Fig. 8. *Conus cowlitzensis* Weaver,  $\times 1$ . Cotype from Cal. Acad. Sci. Locality 182.  
Fig. 9a. *Conus hornii* Gabb,  $\times 1$ . Cotype from Cal. Acad. Sci. Locality 244.  
Fig. 9b. *Conus hornii* Gabb,  $\times 1$ .  
Fig. 9c. *Conus hornii* Gabb,  $\times 1$ .  
Fig. 10. *Conus weaveri*, new species,  $\times 2$ . Type.  
Fig. 11a. *Mitra washingtoniana* Weaver,  $\times 1$ . Cotype.  
Fig. 11b. *Mitra washingtoniana* Weaver,  $\times 1$ . Mouth view.  
Fig. 12. *Mitra simplicissima* Cooper,  $\times 2$ . Cotype from Univ. of Cal. Locality 2226, Rose Canyon.  
Fig. 13a. *Mitra uvasana*, new species,  $\times 1$ . Type from Cal. Acad. Sci. Locality 244.  
Fig. 13b. *Mitra uvasana*, new species,  $\times 1$ . Cotype. View showing aperture.  
Fig. 14a. *Voluta martini*, new species,  $\times 1$ . Type.  
Fig. 14b. *Voluta martini*, new species,  $\times 1$ . Back view of type.  
Fig. 15. *Voluta*, sp. a,  $\times 3$ . Cal. Acad. Sci. Locality 244.  
Fig. 16. *Voluta slevini*, new species,  $\times 2$ . Type.





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**A LIST OF THE AMPHIBIANS AND REPTILES OF  
UTAH, WITH NOTES ON THE SPECIES IN  
THE COLLECTION OF THE  
ACADEMY.**

By **JOHN VAN DENBURGH**,  
*Curator of the Department of Herpetology,*

and **JOSEPH R. SLEVIN**,  
*Assistant Curator of the Department of Herpetology.*

The reptiles and amphibians of Utah have been but little known. Stansbury's and Wheeler's Surveys, the report on the Death Valley Expedition, Yarrow's Catalogue, and a few notes by Cope, Dickerson, and Van Denburgh include about all that has been published on the subject. Some of the records, particularly those of Yarrow, are open to question. As in the List of Amphibians and Reptiles of Arizona, published in 1913, it has been our aim to exclude from this list all species not definitely known to live within the state. Where we have been in doubt as to the authenticity of a record the species has been omitted.

Our Utah collections are chiefly the result of the efforts of Mr. Slevin during the spring and summer of 1913, but a large number of specimens was secured for us by Chaplain Joseph Clemens, U. S. A., mainly in the vicinity of Fort Douglas. To him our thanks are due.

The following list includes 36 species. Those which the Academy has not yet secured from within the borders of Utah

June 15, 1915

are indicated by a star preceding the number. Following this list are given notes on the species represented in the Academy's collections.

**List of the Amphibians and Reptiles of Utah.**

1. *Ambystoma tigrinum*
- \*2. *Hyla arenicolor*
3. *Chorophilus nigrinus triseriatus*
4. *Bufo boreas*
5. *Bufo lentiginosus woodhousii*
- \*6. *Bufo punctatus*
7. *Scaphiopus hammondi*
8. *Rana pipiens*
9. *Rana pretiosa*
- \*10. *Rana onca*
- \*11. *Sauromalus ater*
12. *Crotaphytus collaris baileyi*
13. *Crotaphytus wislizenii*
- \*14. *Callisaurus ventralis*
15. *Uta stansburiana*
16. *Uta ornata*
17. *Sceloporus graciosus*
18. *Sceloporus elongatus*
- \*19. *Sceloporus biseriatus*
- \*20. *Sceloporus consobrinus*
- \*21. *Sceloporus magister*
22. *Phrynosoma douglassii*
23. *Phrynosoma platyrhinos*
24. *Cnemidophorus tigris*
25. *Eumeces skiltonianus*
26. *Charina bottæ*
- \*27. *Sonora semiannulata*
- \*28. *Salvadora grahamiæ*
29. *Hypsiglena ochrorhynchus*
30. *Bascanion constrictor vetustum*
- \*31. *Bascanion flagellum frenatum*
32. *Bascanion tæniatum*
33. *Pituophis catenifer deserticola*
34. *Thamnophis parietalis*
35. *Thamnophis vagrans*
36. *Crotalus oregonus*

### 1.—*Ambystoma tigrinum* (Green).

No adult salamanders were found but the collections include 32 larval or recently transformed specimens. Eighteen (Nos. 27205, and 30938 to 30954) were sent to us from Fort Douglas, Salt Lake County. The other 14 (Nos. 38664 to 38676) were collected by Mr. Slevin at Lake Solitude, Wasatch County, July 3 to 5, 1913. Lake Solitude is at an altitude of about 9000 feet and snow still lay on the ground at this date. The specimens were found under moss and leaves in the water near shore. They have no gills, but do not show any yellow markings. Smaller larvæ three or four inches long, with gills, were also found in the lake at this time. No adults or eggs were seen. In these Lake Solitude salamanders the costal folds vary in number from 12 to 15, being 12 twice, 13 eighteen times, 14 seven times, and 15 once. There is only one specimen which has not 13 grooves on at least one side of the body.

### 3.—*Chorophilus nigrinus triseriatus* (Wied).

A single adult (No. 38677) was found in Provo Canyon, Wasatch Mountains, Wasatch County, May 19 to 26, 1913. It was caught in a little marshy meadow beside the Provo River.

### 4.—*Bufo boreas* Baird & Girard.

Our collections include 87 Utah specimens of this toad. Of these, 37 (Nos. 14375 to 14407, 27289, 27291, 27294 and 27296) were collected near Fort Douglas, Salt Lake County; four (Nos. 14411 to 14414) were taken at Kimballs, near Park City, Summit County; No. 38636 was found in Little Cottonwood Canyon, Wasatch Mts., Wasatch County, June 28-29, 1913; twenty-four (Nos. 38639 to 38662) were secured at an altitude of 8728 feet at the head of Big Cottonwood Canyon, Wasatch Mountains, Wasatch County, July 3-5, 1913; and twenty-one were collected in Provo Canyon, Wasatch Mts., Wasatch County, May 19 to June 20, 1913.

### 5.—*Bufo lentiginosus woodhousii* (Girard).

One hundred and seventy-seven of these toads are at hand from Utah. One hundred and forty-seven of these were col-



lected near Fort Douglas, Salt Lake County (Nos. 14221 to 14334, 14337 to 14349, 14351 to 14355, 14358 to 14361, 27287, 27288, 27290, 27292, 27293, 27295, and 27297 to 27301); twenty (Nos. 38401 to 38420) were secured at Provo, Utah County, June 20, 1913; nos. 38637 and 38638 were caught June 28-29, 1913, in Little Cottonwood Canyon, Wasatch Mountains, Wasatch County; and seven (Nos. 38395 to 38400) were obtained at Green River, Emery County, June 5-7, 1913.

7.—*Scaphiopus hammondi* Baird.

We have received three spadefoot toads (Nos. 14335, 14336, and 27206) from Fort Douglas, Salt Lake County, where they were collected in June and July, 1908, and on May 15, 1909.

8.—*Rana pipiens* Schreber.

Our Utah collections include 104 frogs of this species. Five specimens (Nos. 38389 to 38393) are from Green River, Emery County, June 5 and 6, 1913; forty-five (Nos. 38526 to 38570) were collected in Provo Canyon, Wasatch Mountains, Wasatch County, May 19 to June 13, 1913; fifty-three (Nos. 14115, 14416 to 14462, and 30933 to 30937) were secured near Fort Douglas, Salt Lake County; and No. 14463 was taken at Kimberly, Piute County. These frogs seem not to differ from those in our series from Arizona.

9.—*Rana pretiosa* Baird & Girard.

We have 45 of these frogs from Utah. One (No. 14492) was secured near Fort Douglas, Salt Lake County, and the others (Nos. 38571 to 38614) were collected in Provo Canyon, Wasatch Mountains, Wasatch County, May 19 to June 13, 1913. We are unable to distinguish these frogs from others collected at Klamath Falls, Oregon, and Mt. Rainier, Washington. There appears to be no constant difference in coloration or in plantar or palmar tubercles.

12.—*Crotaphytus collaris baileyi* (Stejneger).

We have 16 of these lizards from Utah. Nine (Nos. 38208 to 38216) are from Thompson, Grand County, May 30 to

June 4, 1913; and seven (Nos. 38032 to 38038) were secured at Newhouse, Beaver County, May 15, 1913. Those from Thompson are much greener than the Newhouse specimens. The central head scales are in two series in all these Utah specimens.

The femoral pores in these specimens vary from 15 to 20; being 15 three times, 16 four times, 17 seven times, 18 eight times, 19 six times, and 20 four times.

**13.—*Crotaphytus wislizenii* Baird & Girard.**

Twenty-two were secured in Utah. Of these, 18 (Nos. 38217 to 38234) were shot near Thompson, Grand County, May 30 to June 4, 1913; two (Nos. 38343 to 38344) at Elgin, in the same county, June 5 to 7, 1913; one (No. 38376) at Green River, Emery County, June 6, 1913; and one (No. 38031) near Newhouse, Beaver County, May 15, 1913.

Femoral pores in these specimens vary from 17 to 24; being 17 twice, 19 three times, 20 seven times, 21 fourteen times, 22 eight times, 23 nine times, and 24 once.

**15.—*Uta stansburiana* Baird & Girard.**

Fifty specimens from Utah are at hand, as follows: Twenty-nine (Nos. 38047 to 38075) from Newhouse, Beaver County, May 15, 1913; three (Nos. 38386 to 38388) from Green River, Emery County, June 5-7, 1913; two (Nos. 38345, 38346) from Elgin, Grand County, June 5, 1913; and 16 Nos. 38326 to 38341) from Thompson, Grand County, May 30 to June 4, 1913.

The femoral pores in 15 specimens from Emery and Grand counties vary from 13 to 16; being 13 twice, 14 ten times, 15 fourteen times, and 16 four times. In 24 lizards from Newhouse the pores vary from 12 to 16; being 12 once, 13 nine times, 14 twenty times, 15 fifteen times, and 16 three times.

**16.—*Uta ornata* Baird & Girard.**

This lizard was found at Thompson, Grand County, where 22 specimens (Nos. 38304 to 38325) were collected May 30 to June 4, 1913. Utah specimens seem not to differ from those taken in Arizona. Femoral pores in 17 specimens vary from 12 to 16; being 12 five times, 13 fifteen times, 14 eleven times, 15 twice, and 16 once.

**17.—*Sceloporus graciosus* Baird & Girard.**

We have 94 specimens from Utah. There are four (Nos. 38300 to 38303) from Thompson, Grand County, May 30 to June 4, 1913; 29 (Nos. 38497 to 38525) from the Wasatch Mountains, Wasatch County, May 19 to June 20, 1913; 44 (Nos. 14159 to 14162, 27159 to 27195, and 30927 to 30929) from Fort Douglas, near Salt Lake City, Salt Lake County; eight (Nos. 38085 to 38092) from Beaver, Beaver County, May 13, 1913; and nine (Nos. 38076 to 38084) from Milford, Beaver County, May 16, 1913.

Femoral pores in 90 specimens vary from 9 to 16; being 9 once, 11 twelve times, 12 fifty-three times, 13 sixty-nine times, 14 twenty-five times, 15 seventeen times, and 16 three times.

**18.—*Sceloporus elongatus* Stejneger.**

We refer to this species 65 specimens (Nos. 38235 to 38299) collected at Thompson, Grand County, May 30 to June 4, 1913. Femoral pores in 64 of these vary from 16 to 22; being 16 eight times, 17 eighteen times, 18 thirty-four times, 19 thirty times, 20 twenty-four times, 21 ten times, and 22 four times. The dorsal scales in a row from the interparietal plate to a line joining the backs of the thighs in 45 of these lizards vary from 44 to 50; being 44 four times, 45 five times, 46 nine times, 47 ten times, 48 eight times, 49 once, and 50 eight times.

Dr. Stejneger, at our request, has very kindly compared three of these specimens with the original specimens of *S. elongatus*, and writes that he finds them identical. It is interesting to find in Utah this species which has been known only from the original Arizonan specimens. This species differs from *S. biseriatus* in general coloration, in having two blue spots on the throat (as in *S. occidentalis* and *S. consobrinus*) and in its smaller dorsal scales. We are not certain that Utah records of *S. consobrinus* may not be based, at least in part, on this species, although the coloration is quite different. *S. smaragdinus* was originally described from specimens from Utah and Nevada, but its 14 femoral pores, 41 scales from head to base of tail, and entire middle portion of throat blackish blue, indicate that it was based upon specimens of *S. biseriatus*.

**22.—*Phrynosoma douglassii* (Bell).**

The collection includes 18 of these horned toads. One (No. 38342) was caught near Thompson, Grand County, May 30 to June 4, 1913; sixteen (Nos. 14153 to 14158, 14493 to 14494, 27156 to 27158, and 30930 to 30932, 38763, 38764) were collected in the vicinity of Fort Douglas, Salt Lake County; and one (No. 38093) was taken near Beaver, Beaver County, May 13, 1913.

Femoral pores in 16 specimens vary from 13 to 17; being 13 four times, 14 eight times, 15 twelve times, 16 six times, 17 twice. This form differs from *Phrynosoma hernandesi* principally in its shorter cephalic horns and larger scales on the belly.

**23.—*Phrynosoma platyrhinos* Girard.**

We have only one specimen (No. 38039) caught at Newhouse, Beaver County, May 15, 1913. Its femoral pores are 9-9.

**24.—*Cnemidophorus tigris* Baird & Girard.**

One hundred and twenty-seven Utah specimens are in our collections. One hundred and eight (Nos. 38099 to 38207) were shot at Thompson, Grand County, May 30 to June 4, 1913; nine (Nos. 38377 to 38385) were collected at Green River, Emery County, June 5, 6, 1913; three (Nos. 14163, 14496, 14497) were secured near Fort Douglas, Salt Lake County; and seven (Nos. 38040 to 38046) were taken at Newhouse, Beaver County, May 15, 1913.

The femoral pores in 124 of these specimens vary from 17 to 23; being 17 three times, 18 seventeen times, 19 forty-five times, 20 fifty-seven times, 21 sixty-one times, 22 fifty times, and 23 fifteen times. The average number of pores on the 248 thighs is 20.47, as against 20.64 on 160 thighs of specimens from Yuma, Arizona.

**25.—*Eumeces skiltonianus* (Baird & Girard).**

Four skinks of this species (Nos. 38094 to 38097) were caught under stones in the oak belt of the foothills near Mt. Baldy, Beaver County, May 13, 1913. They seem to be typical in coloration and scale characters. The scales around the mid-

dle of the body are 26, 24, 26, 24, and in a row from the back of the head to a line joining the backs of the thighs one counts 56, 56, 57, 57 scales.

We believe this skink has not before been recorded east of California. Yarrow mentions *Eumeces obsoletus* as having been taken in Utah, but his records are open to question until confirmed.

## 26.—*Charina bottæ* (Blainville).

We have seven of these boas from Utah. No. 38421 was found in Little Cottonwood Canyon, Wasatch Mts., Wasatch County, June 28, 1913; four (Nos. 38422 to 38425) were secured in Provo Canyon, in the Wasatch Mountains, May 19 to June 20, 1913. The other two (Nos. 27197 and 38762) were collected near Fort Douglas, Salt Lake County. This species seems not to have been taken previously east of Nevada. Variation in scale-counts is shown in the following table:

No.	Sex	Scale rows	Gastrosteges	Urosteges	Supralabials	Infralabials	Loreals
27197	♂	41	208	39	—	—	—
38421	♀	41	205	33	10—10	13—11	1—1
38422	♀	41	207	33	10—10	10—10	1—1
38423	♂	41	206	35	9—9	10—10	1—1
38424	♀	41	204	34	9—10	11—11	1—1
38425	♀	41	210	35	9—9	11—11	1—1
38762	♂	41	202	—	9—9	11—11	1—1

## 29.—*Hypsiglena ochrorhynchus* Cope.

We have two snakes of this kind (Nos. 30925 and 30926) collected near Fort Douglas, Salt Lake County, in 1910.

No. 30925, a female, has 21 scale-rows, gastrosteges 182, urosteges 49, anal divided, supralabials 8—8, infralabials 10—10, preoculars 1—1, postoculars 2—2, temporals 1+2—1+2, loreal 1—1, posterior genials shorter.

No. 30926, a male, has 21 scale-rows, gastrosteges 177, urosteges 50, anal divided, supralabials 7—7, infralabials 9—9, preoculars 1—1, postoculars 2—2, temporals 1+1—1+2, loreal 1—1, posterior genials shorter.

We do not know of any previous record of this snake for Utah.

30.—*Bascanion constrictor vetustum* (Baird & Girard).

This snake evidently is common in Utah. We have secured 30 specimens. Thirteen of these (Nos. 38426 to 38438) are from Provo Canyon, Wasatch Mountains, Wasatch County, May 19, to June 20, 1913. The other 17 are from Fort Douglas, Salt Lake County. Variation in scale characters is shown in the following table:

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals
38426	♂	17	171	90	7-7	8-8	2-2	2-2	1-1	2+2-2+2
38427	♀	17	164	83	7-8	8-8	2-2	2-2	1-1	2+2-2+2
38428	♀	17	170	82	8-8	9-8	2-2	2-2	1-1	2+2-2+2
38429	♀	17	176	85	7-8	8-7	2-2	2-2	1-1	2+2-2+2
38430	♂	17	164	94	8-8	9-8	2-2	2-2	1-1	2+2-2+2
38431	♂	17	167	90	7-7	8-8	2-2	2-2	1-1	2+2-2+2
38432	♀	17	172	91	8-8	9-9	2-2	2-2	1-1	2+2-2+2
38433	♂	17	168	90	7-7	8-8	2-2	2-2	1-1	2+2-2+2
38434	♂	17	170	97	7-8	8-8	2-2	2-2	1-1	2+2-2+2
38435	♀	17	165	86	7-8	8-8	2-2	2-2	1-1	2+2-2+2
38436	♀	17	172	..	7-8	8-8	2-2	2-2	1-1	2+2-2+2
38437	♀	17	171	86	8-8	8-8	2-2	2-2	1-1	2+2-2+2
38438	♂	17	164	89	7-7	8-7	2-2	2-2	1-1	2+2-2+2
14164	♂	17	172	..	8-7	8-8	2-2	2-2	1-1	2+2-2+2
14165	♀	17	..	82	..	..	..	..	..	..
14168	♂	17	173	..	7-7	9-8	2-2	2-2	1-1	2+2-2+2
14170	♂	17	170	88	7-8	8-8	2-2	2-2	1-1	2+2-2+2
14171	♂	17	169	..	8-8	..	2-2	2-2	1-1	2+2-2+2
14172	♂	17	170	102	X-7	X-8	2-2	2-2	1-1	2+2-2+2
14173	♀	17	173	90	8-8	8-8	2-2	2-2	1-1	2+2-2+2
14174	♂	17	176	95	8-8	8-8	2-2	2-Q	1-1	2+2-2+2
14175	♂	17	172	98	8-8	9-X	2-2	2-2	1-1	2+2-2+2
14176	♀	17	172	86	7-8	8-8	2-2	2-2	1-1	2+2-2+2
14177	♂	17	168	87	8-7	8-8	2-2	2-2	1-1	2+2-2+2
27200	♂	17	171	95	8-8	8-8	2-2	2-2	1-1	2+2-2+2
27201	♀	..	..	88	7-8	X-8	2-2	2-2	1-1	2+2-2+2
27202	♂	17	169	102	7-8	8-8	2-2	2-2	1-1	2+2-2+2
27203	♀	17	172	85	7-8	9-8	2-2	2-2	1-1	2+2-2+2
27204	♀	17	176	..	7-8	8-8	2-2	2-2	1-1	2+2-2+2
38760	♀	17	173	87	7-7	9-9	2-X	2-2	1-1	2+2-2+2

32.—*Bascanion tæniatum* (Hallowell).

Four specimens from Fort Douglas, Salt Lake County, have the following scale counts:

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals
14167	♂	15	202	140	8-8	X-X	2-2	2-2	1-1	2+2-2+2
30923	♀	15	202	131	8-8	X-9	2-2	2-2	1-1	2+2-2+2
30924	♀	15	204	..	8-8	8-7	2-2	2-2	1-1	2+2-2+2
38761	♀	15	209	127	8-8	9-9	2-2	2-2	1-1	2+2-2+2

33.—*Pituophis catenifer deserticola* Stejneger.

Twenty-eight of these snakes are at hand. No. 38755 was secured in Provo Canyon, Wasatch Mountains, Wasatch

County, June 26, 1913. The others are all from Fort Douglas, Salt Lake County. The following table gives the variation in scale characters:

No.	Sex	Scale rows	Gastrosteges	Urosteges	Supralabials	Infralabials	Preoculars	Postoculars	Loreals	Temporals
14193	♂	31	238	67	8-8	12-X	1-1	2-2	1-1	4+5-4+4
14194	♂	29	239	59	8-8	12-X	1-1	2-2	1-1	3+3-3+4
14195	♂	31	238	66	8-8	11-11	1-1	2-2	1-1	3+3-3+4
14196	♂	29	231	68	8-8	11-11	1-1	2-2	1-1	3+3-3+4
14197	♂	29	228	66	8-8	12-12	1-1	2-2	1-1	3+3-3+4
14198	♂	29	238	61	8-8	13-13	1-1	3-3	1-1	4+4-3+4
14199	♂	27	234	70	9-X	13-X	1-1	3-3	1-1	2+3-2+4
14200	♂	27	231	70	8-9	12-13	1-1	2-2	1-1	3+4-3+4
14201	♂	25	234	66	8-8	13-13	1-1	3-3	1-1	3+4-3+4
14202	♂	31	234	70	9-9	13-13	1-1	3-3	1-1	3+4-2+4
14203	♂	29	238	66	9-9	12-12	1-1	2-2	1-1	4+4-3+4
14204	♂	27	237	62	8-8	13-12	1-1	2-2	1-1	3+4-4+4
14205	♂	29	236	67	8-8	13-12	1-1	2-2	1-1	3+4-4+4
14206	♂	29	236	66	8-8	13-12	1-1	2-2	1-1	3+4-4+4
14207	♂	29	233	60	8-8	13-14	1-1	3-3	1-1	4+5-4+5
27198	♂	31	232	68	8-8	13-13	1-1	3-3	1-1	3+3-3+4
27199	♂	29	230	63	8-8	13-12	1-1	3-3	1-1	3+4-3+3
30913	♂	29	228	66	8-8	X-12	1-1	3-3	1-1	4+4-4+4
30914	♂	29	236	60	9-8	12-12	1-1	3-3	1-1	4+X-3+4
30915	♂	29	238	67	9-9	13-13	1-1	2-2	1-1	3+4-X+X
30916	♂	31	240	61	9-9	13-13	1-1	2-2	1-1	4+4-3+4
30917	♂	29	227	65	8-8	12-13	1-1	2-3	1-1	4+4-3+4
30918	♂	29	233	58	9-8	12-12	1-1	2-2	1-1	4+4-4+4
30919	♂	27	228	66	8-8	12-13	1-1	3-3	1-1	3+4-3+4
30920	♂	29	223	55	8-9	11-12	2-2	3-3	1-1	3+4-3+4
38755	♂	31	237	70	8-9	11-11	2-2	3-3	1-1	3+4-3+4
38756	♂	29	230	71	9-9	13-13	1-1	2-2	1-1	3+4-3+4
38757	♂	29	232	62	8-8	13-13	1-1	2-2	1-1	4+5-4+4

#### 34.—*Thamnophis parietalis* (Say).

The only specimen of this snake in our collections from Utah is a female, No. 14169, secured near Fort Douglas, Salt Lake County, in June or July, 1908. Its scales are in 19 rows, gastrosteges 166, urosteges 75, supralabials 7-7, infralabials 10-10, preoculars 1-1, postoculars 3-3, loreal 1-1, temporals 2+3-1+2, posterior genials longer.

#### 35.—*Thamnophis vagrans* (Baird & Girard).

This snake evidently is much more abundant in Utah than *Thamnophis parietalis*. We have 60 specimens. Nos. 14166, 38758 and 38759 were caught near Fort Douglas, Salt Lake County. All the others were collected in Provo Canyon, Wasatch Mountains, Wasatch County, May 19 to June 20, 1913. All show the typical coloration. Variation in scale characters is given in the following table:

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals
14166	♂	21	170	75	X-8	X-10	1-1	3-3	1-1	1+2+3-1+2+3
38758	21	164	81	8-8	8-8	10-10	2-2	4-3	1-1	1+2+3-1+2+3
38759	21	168	78	8-8	8-8	9-X	1-1	3-3	1-1	1+2+3-1+2+3
38440	21	170	83	8-8	8-8	10-10	2-2	3-3	1-1	1+2+3-1+2+3
38441	21	162	73	7-8	10-10	1-1	4-3	1-1	1-1	1+2+3-1+2+3
38442	21	173	..	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38443	21	160	..	8-8	10-10	2-2	4-4	1-1	1-1	1+2+3-1+2+3
38444	21	163	75	8-8	10-10	1-1	4-4	1-1	1-1	1+2+3-1+2+3
38445	21	174	93	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38446	21	169	87	8-8	10-10	1-1	3-4	1-1	1-1	1+2+3-1+2+3
38447	21	171	83	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38448	21	169	65	8-8	10-10	1-1	3-4	1-1	1-1	1+2+3-1+2+3
38449	21	161	70	8-8	10-10	1-1	3-4	1-1	1-1	1+2+3-1+2+3
38450	21	172	90	8-8	10-10	1-1	3-4	1-1	1-1	1+2+3-1+2+3
38451	21	166	76	8-9	11-11	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38452	21	162	71	8-8	10-10	2-2	3-3	1-1	1-1	1+3+4-1+2+3
38453	21	163	74	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38454	21	171	75	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38455	21	167	75	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+3+3
38456	21	162	70	8-8	11-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38457	21	166	73	8-8	10-9	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38458	21	168	..	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38459	21	171	73	8-8	9-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38460	21	162	81	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38461	21	159	85	8-8	10-X	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38462	21	165	78	8-8	10-10	1-1	3-4	1-1	1-1	1+2+3-1+2+3
38463	21	172	86	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38464	21	166	82	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38465	21	169	91	8-8	10-10	1-1	4-3	1-1	1-1	1+2+3-1+2+3
38466	21	167	86	8-8	10-10	1-1	3-3	1-1	1-1	1+2+4-1+2+3
38467	21	173	88	7-8	10-9	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38468	21	171	88	8-8	10-11	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38469	21	169	77	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38470	21	160	88	8-8	11-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38471	21	163	74	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38472	21	173	75	8-7	9-9	2-2	4-4	1-1	1-1	1+2+3-1+2+3
38473	21	167	88	8-8	10-10	1-1	4-3	1-1	1-1	1+2+4-1+2+3
38474	21	170	84	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38475	21	174	83	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38476	21	173	80	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38477	21	175	90	8-8	9-9	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38478	21	166	..	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38479	21	173	87	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38480	21	172	..	8-8	10-10	1-1	3-3	1-1	1-1	1+3+4-1+2+3
38481	21	158	77	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38482	21	172	82	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38483	21	168	81	8-8	9-9	1-1	2-2	1-1	1-1	1+2+3-1+2+3
38484	21	167	70	8-8	10-10	1-2	3-4	1-1	1-1	1+2+3-1+2+3
38485	21	160	77	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38486	21	166	77	7-8	9-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38487	21	164	78	8-8	10-9	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38488	21	172	78	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38489	21	173	79	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38490	21	168	82	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38491	21	174	83	8-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38492	21	172	85	7-8	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38493	21	173	77	8-8	9-10	1-1	4-4	1-1	1-1	1+2+3-1+2+3
38494	21	172	85	8-7	10-10	1-1	3-3	1-1	1-1	1+2+3-1+2+3
38495	21	169	85	8-8	10-10	1-1	4-4	1-1	1-1	1+2+3-1+2+3
38496	21	177	89	7-8	10-10	1-1	3-4	1-1	1-1	1+3+3-1+2+3

36.—*Crotalus oregonus* Holbrook.

Our collections include seven rattlesnakes from Utah. Six of these are typical *C. oregonus* in color and scale characters. The seventh (No. 38098) seems to agree with the others in squamation, but is creamy white in color without any darker markings. This last specimen was caught out on the sandy



desert south of Thompson, Grand County, May 30 to June 4, 1913. No. 38439 was secured in Provo Canyon, in the Wasatch Mountains, Wasatch County, May 19-26, 1913. The other five were collected near Fort Douglas, Salt Lake County.

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals
14208	♂	25	178	..	16-X	16-X	2-X	....	1-X
14209	♂	27	180	..	14-14	15-X	X-2	....	....
27196	♂	25	171	24	15-16	15-16	2-2	3-3	1-1
30921	♀	25	179	20	15-15	15-15	2-2	3-3	1-1
30922	♂	25	179	24	15-17	17-17	2-2	3-3	....
38098	♂	25	178	22	15-16	15-16	2-2	3-3	....
38439	♂	25	175	18	16-15	16-14	2-2	3-3	1-1



Fig. 1. *Ambystoma tigrinum* (Green). Tiger Salamander. Young with gills. Lake Solitude, Wasatch County, Utah, July 3-5, 1913.



Fig. 2. *Sceloporus graciosus* Baird & Girard. Mountain Lizard. Provo Canyon, Wasatch County, Utah, May 23, 1913.





Fig. 3. *Charina botta* (Blainville). Rubber Snake. Adult female. Little Cottonwood Canyon, Wasatch Mountains, Wasatch County, Utah, June 28, 1913.



Fig. 4. *Bascania constrictor retusum* Baird & Girard. Western Yellow-bellied Racer. Provo Canyon, Wasatch Mountains, Wasatch County, Utah, May 23, 1913.





Fig. 5. *Pituophis catenifer deserticola* Stejneger. Desert Gopher Snake. Adult male. Provo Canyon, Wasatch Mountains, Wasatch County, Utah, June 26, 1913.



Fig. 6. *Thamnophis vagrans* (Baird & Girard). Wandering Garter Snake. Provo Canyon, Wasatch Mountains, Wasatch County, Utah, June, 1913.



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**DESCRIPTION OF A NEW SUBGENUS (*ARBORIMUS*)  
OF *PHENACOMYS*, WITH A CONTRIBUTION  
TO KNOWLEDGE OF THE HABITS AND  
DISTRIBUTION OF *PHENACOMYS*  
*LONGICAUDUS* TRUE**

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**CONTENTS**

	Page
A. INTRODUCTION .....	113
B. MATERIAL AND ACKNOWLEDGMENTS.....	117
C. <i>ARBORIMUS</i> , A NEW SUBGENUS OF <i>PHENACOMYS</i> .....	119
I GEOGRAPHIC DISTRIBUTION OF TYPE SPECIES AND SUBGENUS.....	119
II ESSENTIAL CHARACTERS OF <i>Arborimus</i> .....	119
III DESCRIPTION OF <i>Phenacomys longicaudus</i> TRUE.....	119
1 CRANIAL CHARACTERS .....	119
(1) Skull in general .....	119
(2) Back upper molar .....	121
(3) Front lower molar .....	122
(4) Second lower molar .....	125
(5) Third lower molar .....	126
2 EXTERNAL CHARACTERS .....	127
(1) General coloration .....	127
(2) Dorsal coloration .....	127
(3) Ventral coloration .....	128
(4) Length of tail .....	128
(5) Tuberculation of feet and the number of mammaræ .....	131
(6) The type of <i>Phenacomys longicaudus</i> .....	131
(7) The specimen from Meadows, Lane County, Oregon .....	131
(8) Pelages .....	131
IV RELATIONS OF <i>Phenacomys albipes</i> TO THE TWO SUBGENERA OF <i>Phenacomys</i> .....	132

December 30, 1915.

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STANFORD UNIVERSITY



	Page
D. DISTRIBUTION AND HABITS OF <i>PHENACOMYS LONGICAUDUS</i> .....	136
I DISTRIBUTION .....	136
1 IN TIME .....	136
2 IN SPACE .....	136
II HABITS .....	138
1 GENERAL HABITAT .....	138
2 KINDS OF TREES INHABITED .....	139
3 COLONIAL TENDENCY .....	140
4 OBSERVED MOVEMENTS .....	141
5 VOICE .....	142
6 FOOD AND DRINK .....	142
7 HOME RANGE OF THE INDIVIDUAL .....	144
8 HIBERNATION .....	144
9 STUDIES OF THE NEST .....	145
(1) Altitude above the ground.....	145
(2) Position in trees .....	145
(3) General size .....	145
(4) Skeleton, form and makeup.....	146
(a) Possible parasitism of <i>Phenacomys longicaudus</i> .....	146
(b) Form and composition of nests.....	146
(c) The inner nest cavity.....	149
(5) Large nests the work of years.....	150
(6) Desertion of nests .....	150
10 BREEDING HABITS AND FAMILY RELATIONS.....	151
(1) Time of breeding and size of families.....	151
(2) Preponderance of females .....	152
(3) Family relations .....	153
E. THE POSSIBLE ANCESTRY OF <i>PHENACOMYS LONGICAUDUS</i> .....	154
F. SUMMARY .....	156
G. LIST OF WORKS CONTAINING IMPORTANT MATERIAL RELATIVE TO THE GENUS.....	158

## A INTRODUCTION

Dr. C. Hart Merriam, in describing *Phenacomys albipes* (1901, p. 125), referred to *Phenacomys longicaudus* as being one of the rarest and least known mammals of the world. At that time only three specimens of *longicaudus* had been collected: the type, at Marshfield, Coos County, Oregon, an aberrant specimen at Meadows, Lane County, in the same state, and an example found dead on a road at Lierly's Ranch, near Mt. Sanhedrin, Mendocino County, California. The specimens from Oregon were transmitted to the United States National Museum by Aurelius Todd of Eugene; while the lone example from California, collected by A. S. Bunnell, was part of a collection which went to the Academy of Natural Sciences of Philadelphia.

The species first became formally known to science through the publication of the original description by True (November 15, 1890). For twenty-two years thereafter the species was represented in the museums of the United States by not more than the three specimens mentioned above.

According to Bailey (1915, p. 148) Dr. William Bebb of Los Angeles, in 1907, showed him several specimens of the tree mouse which he had taken at an Oregon lumber camp. "The men were chopping down tall Douglas spruces and he watched when the trees came down and caught several of the stunned or crippled mice as the nests were crushed by the fall."

In 1912 a specimen was secured by a game warden on the slope of Chaparral Mountain above Maplecreek Postoffice, Humboldt County, California, and turned over to Mr. C. I. Clay, of Eureka, who forwarded it to the Museum of Vertebrate Zoology of the University of California. The following year, through the activities of the California North Coast Counties Expedition sent out from the same Museum, sixteen specimens were collected at Mendocino City, Mendocino County, California, and one at Lierly's Ranch, four miles south of Mount Sanhedrin, in the same county. During the spring and fall of 1913, Mr. H. E. Wilder, of Carlotta, Humboldt County, California, collected and transmitted to the Museum of Vertebrate Zoology a series of thir-

teen specimens, one taken at Cuddeback, and twelve at Carlotta, Humboldt County. In February, 1914, Professor John F. Bovard and Mr. Alfred C. Shelton, of the University of Oregon, secured three more on Spencer Butte, seven miles south of Eugéné, Oregon; and in June of the same year Mr. Vernon Bailey, of the Bureau of Biological Survey of the United States Department of Agriculture, collected an additional specimen in the same locality.

During these later years other specimens, of which the present writer has no record, may well have been collected; for the species is fairly abundant and widely distributed in certain sections of the humid coast belt, and its meager representation in collections is obviously to be accounted for through ignorance of its habits rather than any actual rarity.

Doubtless a few residents in localities where the species occurs have long known of its existence. Our attention, while working at Mendocino City, was first called to it by small boys. In a letter to the writer Mr. Wilder states that middle-aged men have told him of getting these "red mice" around the school house when they were pupils there.

The comparative recency of knowledge of *Phenacomys longicaudus* on the part of systematists, and the poverty of material representative of it, have had two effects, one beneficial, the other detrimental: The species has been preserved from the burden of synonymy which so involves all our more widely known species, it never, in fact, having been known by any other name than the one which it bears at present; and it has previous to the present time been impossible to determine with any definiteness the systematic and ecologic status of the species. This paper aims to be a contribution to the latter problem.

It should perhaps be here noted that the name "lemming-mouse," which has been applied to *Phenacomys*, is not strictly correct. For this name should be reserved for the members of the supergeneric group of the *Lemmi*, which includes *Synaptomys*, *Dicrostonyx* and *Lemmus*. On the other hand *Phenacomys* belongs to the supergeneric group of the *Microti*, or voles, which includes also *Fiber*, *Evotomys* and *Microtus* (see Miller, 1896, p. 8).

As regards their habits the *Microtinæ* are notably adaptable. The situations in which they are found are many and varied. They are encountered “. . . from sea beaches to marshes and Alpine mountain tops, and from open plains to the densest forests . . . . While the great majority of species spend much of their time on the surface, protected by the overhanging vegetation, a few live almost exclusively underground, and in consequence of this habit have acquired numerous modifications which fit them for the needs of a subterranean life. Others are amphibious and never occur at any great distance from water” (Miller, 1896, p. 10). Of all members of this great subfamily, *Phenacomys longicaudus* is unique in its choice of an arboreal habitat; and we may well inquire as to whether this peculiar habit may not be weighted as of importance in the classification of the species. The use of habit characters is not without precedent in the *Microtinæ*. Before the publication of De Selys Longchamps’ “Essai Monographique sur les Campagnoles des environs de Liege,” 1836, the voles had been divided into two groups according to their habits, the aquatic species being separated from those that are strictly terrestrial. But beginning with and subsequent to this author habits as characteristics of the organism appear to have been left out of count in the classifications of the group.

Miller (1896, p. 24) has clearly shown the impracticability of the subdivision of the genus *Microtus*, and the same holds with regard to the subfamily *Microtinæ*, according to the variations in any *one* set of characters, and in his own work bases the classification upon an assemblage of characters, all drawn from the province of *physical* peculiarities. Of these the following are regarded as the more important: form of skull, structure of bony palate, pattern of enamel folding, number of mammæ, number of plantar tubercles, and presence or absence of musk glands on the sides. Regarded as of lesser importance are: quality of fur, hairiness of soles, length of tail, form of front feet, size of eyes, and form of external ear.

It would appear that the greater the assemblage of characters on which a classification is based, so long as such characters are comparable in degree of constancy, the more ade-

quate the classification. In the present paper characters have been freely drawn from two important additional provinces, namely those of *geographical distribution* and of *habits*.

In general, characteristics from these provinces are not sufficiently well known to permit of their use to any great extent. Confessedly, also, such characters, especially those from habits, are often less tangible and far less convenient than physical characters, but as information is accumulated they must certainly find larger place in taxonomic considerations.

In view of the aberrant nature of *Phenacomys longicaudus* there would seem to be some argument for the erection of a new genus for its reception. It seems to the writer, however, that a principle given expression by several authors, notably Osgood (U. S. Dept. Agric., Bureau Biol. Surv., N. Amer. Fauna 28, 1909, pp. 24, 25), and Sumner (Science, June 18, 1915, pp. 899-902), should be recognized, namely, that in a classification which is inevitably critically analytic, the synthetic phase should not be forgotten. The multiplication of genera for the purpose of emphasizing group differences which are comparatively slight would seem to be unwise.

In the present instance, particularly, the chance that the fundamentally close relationship of *Phenacomys longicaudus* to the genus *Phenacomys* will be overlooked is greater than the chance that its differences therefrom will not be appreciated, so it has seemed wisest to accord it subgeneric rank only.

The chief characteristic of our knowledge of mammalian life-histories is its incompleteness. It is estimated that of even our best known species the life-history material available is only five to twenty-five per cent of what it should be. These considerations emphasize the obligation imposed upon the investigator to put on published record such facts regarding habits as he may discover.

While it is to be hoped that the study of morphology will be no less vigorously prosecuted in the future than in the past, it would seem desirable that the study of psychological predilections and associational relations be much more emphasized in the future than in the past. Habits and associa-

tional relations are just as much a part of the animal as are its physical characters. They are just as distinctive specifically; and there is no good reason why they should not be accorded just as full treatment.

## B MATERIAL AND ACKNOWLEDGMENTS

The following specimens constitute the material basis for this study:

*Phenacomys intermedius*—Total number, 3. Alberta, head of Smoky River, 2 (U. S. National Museum). British Columbia, South Fork Moose River, 4525 feet, 1 (U. S. National Museum).

*Phenacomys orophilus*—Total number, 17. Washington: Mt. Rainier, 5000 feet, 2 (U. S. National Museum). Montana: Bear Tooth Mountains, 1 (Biol. Surv. Coll.). Idaho: Sawtooth, 2; Salmon River Mountains, 1 (all from Biol. Surv. Coll.). Oregon: Lane County, Three Sisters Mountain, North Base, 5000 feet, 1 (Coll. Univ. Oreg. Mus. Dept. Zool.); Lane County, Three Sisters Mountain, N. W. slope, 7400 feet alt., 1 (Coll. Oregon Game Department); Crook County, Deschutes River, Mouth of Davis Creek, 1 (Coll. Oregon Game Department). California: Mt. Shasta, Squaw Creek, alt. 7800 feet, 2 (1, skull only); Mount Shasta, head of Squaw Creek, 1; Tuolumne Meadows, 2; Mt. Lyell, 2; Mono Pass, 1 (all from Biol. Surv. Coll.); Pyramid Park (= Peak), 1 (Coll. Field Mus. Nat. Hist.). Canada: Northwest Territory, Red Deer River, 1 (Coll. Field Mus. Nat. Hist.).

*Phenacomys albipes*—Total number, 2. Oregon: Lane County, 2 miles W. of Vida, 1 (Coll. Oregon Game Department). California: Humboldt Bay, Arcata (in redwoods), 1 (the type, Biol. Surv. Coll.).

*Phenacomys olympicus*—Total number, 9. Washington: Happy Lake, 8; Boulder Lake, 1 (all from Coll. Field Mus. Nat. Hist.).

*Phenacomys longicaudus*—Total number, 37. Oregon: Coos County, Marshfield, 1 (the type, U. S. National Museum); Lane County, Meadows, 1 (Biol. Surv. Coll.); Eugene, 4 (1 from Biol. Surv. Coll., 3 from Coll. Univ. Oreg. Mus.

Dept. Zool.). California: Humboldt County, Mad River, Big Bend, southeast from Kneeland, Chaparral Mountain, on slope above Maplecreek Post Office, 12; Carlotta, 12; Cuddeback, 1; Mendocino County, Mendocino City, 16 (4 in alcohol); Lierly's Ranch, 4 miles south of Mount Sanhedrin, 1 (all Coll. Mus. Vert. Zool. Univ. Calif.).

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The writer takes this occasion also to express his appreciation of the valued criticisms and suggestions furnished by Dr. Joseph Grinnell of the University of California under whose immediate supervision the work was carried on.

## C *ARBORIMUS*, A NEW SUBGENUS OF *PHENACOMYS*

### I GEOGRAPHIC DISTRIBUTION OF TYPE SPECIES AND SUBGENUS.

*Phenacomys longicaudus* True, the type species of the new subgenus, is found in southwestern Washington and northwestern California. *Phenacomys albipes*, tentatively referred to *Arborimus*, occurs in the same general locality. (See map, fig. 4, p. 137.)

### II ESSENTIAL CHARACTERS OF *Arborimus*.

Palate tending to be different posteriorly from that in the subgenus *Phenacomys*.

M<sup>3</sup> with second outer triangle tending to be closed off from posterior loop; posterior loop tending to be more rounded, and less emphatically drawn out antero-posteriorly than in *Phenacomys*.

Triangles and loops of M<sub>1</sub> tending to open into one another, except in *albipes*.

Antero-external loop of M<sub>2</sub> never closed off, tending to be smaller than in most examples of *Phenacomys*.

Outer triangle on M<sub>2</sub> tending to be smaller and to open into opposing triangles, except in *albipes*.

M<sub>3</sub> ordinarily simpler than in *Phenacomys*, practically three transverse crescents without external triangle.

Interorbital constriction tending to be narrower than in *Phenacomys*.

Tail proportionally decidedly longer than in *Phenacomys*.

Color a brilliant reddish, except in *albipes*.

Habit arboreal, except in *albipes*, nesting and apparently living entirely in trees.

Distribution, humid coast belt of southwestern Oregon and northwestern California, a section in which no specimen of the subgenus *Phenacomys* has ever been found.

### III DESCRIPTION OF *Phenacomys longicaudus* TRUE

#### 1 CRANIAL CHARACTERS

##### (1) Skull in general

Similar in general characters to that of *Phenacomys*. Crania of *Phenacomys* (*Arborimus*) *longicaudus* have broader brain-



case than those of *P. (Phenacomys) intermedius*, much as in *P. (Phenacomys) orophilus*. The narrower interorbital constriction is the most certainly diagnostic character of the crania of members of the new subgenus (see table of measure-

A Cranial measurements comparative of  
*Phenacomys (Arborimus) longicaudus* and *Phenacomys (Phenacomys) orophilus*

(All measurements in millimeters)

Museum		Greatest length	Zygomatic width	Interorbital constriction <sup>1</sup>	Width of cranium outside external auditory meatus
No.	Sex				
Phenacomys orophilus					
205916	♂ .....	25.8	15.1	3.5	12.0
109103	♂ .....	26.6	.....	3.9	12.2
67327	♂ .....	25.7	14.9	3.6	11.7
110249	♀ .....	25.0	14.9	3.8	11.5
Phenacomys longicaudus					
21145	♂ .....	24.4	14.3	3.0	11.1
21148	♂ .....	24.4	13.9	3.4	11.6
19983	♀ .....	26.1	14.6	3.3	12.4
19174	♀ .....	25.0	15.1	3.4	11.9
21149	♀ .....	25.0	14.2	3.2	11.6
21143	♀ .....	25.2	14.4	3.2	12.4
19973	♀ .....	25.1	14.1	3.3	12.2
19130	♀ .....	24.6	14.3	3.4	11.5
19984	♀ .....	25.8	14.9	3.5	12.4

<sup>1</sup>Miller remarks (1897, p. 80) that the breadth of the interorbital region in *Phenacomys* is a character of trifling importance, which might easily disappear with increasing age. But the character as a good diagnostic feature would seem to hold between the series before me, since the specimens compared are good adults, with the examples of *orophilus* averaging older than those of *longicaudus*.

ments). Palate posteriorly tends to be different in *Arborimus*, usually having lateral pits a little deeper, sloping portion of median ridge longer, and lateral bridges more often present. In *Phenacomys* the lateral pits tend to be shallower, the sloping portion of the median ridge is shorter, in some specimens almost obsolete, and the lateral bridges are more often absent than present. There is overlapping between the subgenera in this respect. Young individuals of *longicaudus* tend to resemble *orophilus* and *intermedius*.

Enamel pattern in *Phenacomys longicaudus* simpler than in certain representatives of the subgenus *Phenacomys*, but not presenting any characters in all cases diagnostic of the new subgenus. The first and second upper molars are practically

identical with those in the subgenus *Phenacomys*, and will not be discussed separately. The front upper molar has, beginning anteriorly, a transverse loop, two inner triangles, one outer triangle, and a postero-external loop. The middle upper molar has transverse loop, one outer triangle, one inner triangle, and a postero-external loop.

(2) Back upper molar

Pattern practically as in the subgenus *Phenacomys*. Beginning anteriorly, the tooth shows a transverse loop, an external triangle, an internal triangle, a second outer triangle, and a postero-internal loop.

In the subgenus *Phenacomys* the outer portion of the posterior "trefoil" ordinarily opens into the inner portion, forming a figure crescentic or boomerang-shaped in outline, the concavity of the crescent or boomerang being directed forward. Sometimes the crescent or boomerang is symmetrical, but usually the inner arm is the heavier. In *Phenacomys longicaudus* the outer portion of the crescent tends to be closed off from the inner portion, forming a second triangle externally and a loop internally, the loop tending to be more rounded than is ordinarily the case in the subgenus *Phenacomys*.

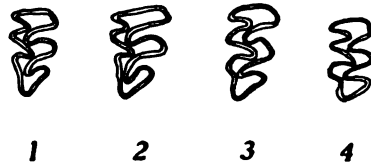


Fig. 1—ENAMEL PATTERN OF BACK UPPER MOLARS OF *PHENACOMYS*.

From left to right these belong to the following species: No. 1, *Phenacomys (Phenacomys) intermedius*; No. 2, *Phenacomys (Phenacomys) orophilus*; No. 3, *Phenacomys (Arborimus) albipes*; No. 4, *Phenacomys (Arborimus) longicaudus*. Traced from photograph. A little less than six times natural size.

Note the development of the second outer triangle and the general difference in outline posteriorly in the new subgenus *Arborimus*.

There is some variation in the tightness of the closure of the second outer triangle in *longicaudus*. In the young the triangle is scarcely formed. In its place is a channel, opening broadly both forward and back and showing on its external

outline a weakly developed salient angle which later becomes the strongly developed salient angle of the triangle. One specimen of *longicaudus* (No. 19976) is unusual in having the second outer triangle opening into the inner triangle forming with it a transverse loop which opens very narrowly into the posterior loop. In a few examples of *longicaudus* (Nos. 21143, 19130, 19174, 19985, and 21154) the second outer triangle opens narrowly into the posterior loop.

In all examples of the subgenus *Phenacomys* at hand, except in one specimen of *P. orophilus* (No. 101058), the outer portion of the crescent or boomerang is not closed to form a second outer triangle, but communicates, usually broadly, with the inner portion.

In the original description of the genus *Phenacomys*, Merriam states (1889, p. 31) that sometimes the outer loop of the trefoil is closed, giving the tooth two external closed triangles and a postero-internal loop. Elliot's illustration (1899b, p. 255) of the upper tooth-row of *olympicus* shows the second outer triangle closed as in *longicaudus*. A cut of the upper tooth-row of *orophilus* published by Merriam (1891, opp. p. 130, pl. III, fig. 3) shows a small second outer triangle closed off from the postero-internal loop, as in *longicaudus*. Similar relations hold in another illustration in the literature (Elliot, 1901, p. 167).

It is clear from these facts that *longicaudus* could not be certainly identified on the enamel pattern of the back upper molar. But there is an average difference between the situation in *longicaudus* and that in subgenus *Phenacomys*, in which latter, ordinarily, the crescent or boomerang looks as if it had been held in the middle while still soft and its arms pulled out anteriorly. In *Arborimus* the outer arm of the crescent becomes the second outer triangle, which is generally closed in both directions, and the postero-internal loop, which is rounded in outline and lies less in an antero-posterior position than the inner arm of the crescent in subgenus *Phenacomys*.

(3) Front lower molar

Agrees with all the species of the genus of which I have material before me in possessing an anterior tripartite trefoil,

with anterior, inner and outer loops all broadly communicating, three long inner and two short outer triangles, and a posterior transverse loop. Certain specimens (as *Phenacomys longicaudus* Nos. 19979 and 21150) have the outer loop of the anterior trefoil closed to form an additional outer triangle. In one specimen of *longicaudus* (No. 42621) both inner and outer loops of the anterior trefoil are constricted to form triangles, though neither triangle is completely closed. The small anterior loop in this specimen bends sharply inward. No. 42621, therefore, has a small anterior loop, four inner and three outer triangles, and posterior transverse loop.

The species of the genus differ more or less constantly in the tightness of closure of loops and triangles. There prevails in *longicaudus* the most open condition which I have observed in the genus; in *albipes* and *intermedius* the closure is tighter; and in *orophilus* it is tightest of all.

No. 21147 is unique among the specimens of *longicaudus* in having the inner reëntrant angles so deep that the second outer triangle is not in evidence. Ordinarily the second inner triangle is closed off from the second outer triangle, while the third inner triangle is not closed. In No. 19983, however, the reverse is true. In one or two examples the molar pattern is slightly different on right and left sides. Teeth which are much worn have the reëntrant angles transformed into lakes, and do not show the enamel pattern characteristic of earlier ages.

In most of the specimens of *longicaudus* the first inner triangle opens into the outer loop of the anterior trefoil, while in *albipes* and in a majority of the specimens of *orophilus* before me it is closed. In three specimens of *intermedius* a narrowly open condition is observed, but in the type specimen of *intermedius*, as figured by Merriam (1889, pl. IV, opp. p. 44), the triangle is closed. Two specimens of *longicaudus* (Nos. 21152, 21147) have the first inner triangle closed off from the outer loop of the anterior trefoil. In No. 19983 the triangle is open on one side but closed on the other, and it is only very narrowly open in two or three examples, notably No. 19130. In most young individuals of *orophilus* the first

inner triangle is not tightly closed, nor is it in *orophilus* No. 95080.

There are no characters in this tooth which distinguish the subgenus *Arborimus* from certain members of the subgenus *Phenacomys*. In Merriam's original description of the genus he uses the following language with reference to the front lower molar (1889, p. 31): "First lower molar with a posterior transverse loop, four greatly elongated internal triangles or digitations, of which at least two are completely closed, an anterior loop of variable shape, and three short external triangles, of which at least one is completely closed." In the illustration of the enamel pattern of *celatus* in Merriam's plate

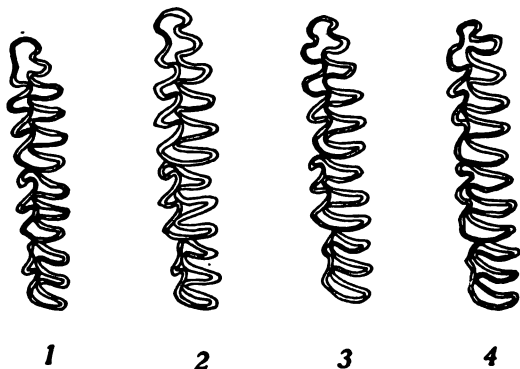


Fig. 2—ENAMEL PATTERN OF MANDIBULAR TEETH OF PHENACOMYS.

No. 1, *Phenacomys (Phenacomys) intermedius*; No. 2, *Phenacomys (Phenacomys) orophilus*; No. 3, *Phenacomys (Arborimus) albipes*; No. 4, *Phenacomys (Arborimus) longicaudus*. Traced from photograph. About six and one-fourth times natural size.

Note that in *Arborimus* the antero-external loop of  $M_2$  is not closed and tends to be smaller than in *Phenacomys*; note the peculiar arrangement of the second outer triangle in *longicaudus*; and finally note the comparative simplicity of  $M_3$  in *Arborimus*.

IV, opposite page 44, the first inner triangle is shown opening broadly into the outer loop of the anterior trefoil as in *longicaudus*. In this specimen also the first inner triangle is shown to open broadly into the first outer triangle. On plate III, facing page 42, the first inner triangle in *P. ungava* is shown opening narrowly into the first outer triangle. Miller (1896, p. 41) has figured the enamel pattern of *celatus*. According to his illustration the first inner triangle opens narrowly both forward and back. These are the only instances I have noted in the literature in which conditions are found similar to those in *longicaudus*.

It seems safe to conclude that *longicaudus* is characterized, with qualifications as above noted, by a more open condition of the loops and triangles of this tooth than in the subgenus *Phenacomys*.

#### (4) Second lower molar

Similar in pattern to *Phenacomys intermedius*, the type of the genus *Phenacomys*. Small antero-external loop, elongated antero-internal triangular digitation, one short outer triangle, one long inner triangle, and a posterior transverse loop.

The small antero-external loop is never closed in *longicaudus*. In one specimen of *intermedius* (No. 174425) the loop is larger than in any specimen of *longicaudus*, with the possible exception of No. 21143, opening broadly into the opposing triangle; in another specimen of *intermedius* (No. 174431) the antero-external loop is only narrowly open; while in a third (No. 174432) the loop is large and opens broadly. All specimens of *orophilus* at hand, with the exception of Nos. 205916 and 67327, have this loop tightly closed off from the opposing triangle. In Merriam's figure 7, illustrative of the genus *Phenacomys* (1889, p. 31) the loop is tightly closed. In his plate III, facing page 42, the antero-external loop both in *celatus* and *ungava* is broadly open as in *longicaudus*. Plate IV, opposite page 44, shows the antero-external loop opening broadly in *latimanus* as well as in *celatus* and narrowly in *intermedius*. In Miller's figure of *celatus* (1896, p. 41) the same relations are shown.

The outer triangle in *longicaudus* tends to be of comparatively small size and not tightly closed off from the antero-internal triangle and the opposed inner triangle. In most specimens the outer triangle opens rather broadly into the opposed inner triangle and narrowly, if at all, into the antero-internal triangle. In *intermedius* the outer triangle is larger than in *longicaudus*, and is closed off in both directions. In *orophilus* there is a considerable range of individual variation in this respect. In four adult examples (Nos. 109103, 67327, 110249, and 205916) the outer triangle is large and is closed.

According to Merriam's plate IV (1889, opp. p. 44) the outer triangle in *latimanus* opens very narrowly anteriorly.

Summarizing, it may be said that while in the subgenus *Phenacomys* the antero-external loop is often closed, it never is in *Phenacomys (Arborimus) longicaudus*; there is also apparent a tendency in the latter for the outer triangle to be smaller and more open than in the subgenus *Phenacomys*.

(5) Third lower molar

Typical of the genus, being made up of three transverse triangular digitations connected along the outer border of the tooth. Tending to be simpler in *P. longicaudus* than in the subgenus *Phenacomys*, in which there is often if not usually a small outer triangle pinched off opposite the middle transverse triangular digitation.

In one specimen of *longicaudus* (No. 21150) this little outer triangle is definitely outlined, though it is not closed off. Similar conditions obtain in several other specimens. There is considerable variation in *orophilus*. In two specimens (Nos. 31249 and 75029) no triangle is outlined, and this is true in several young examples also; but in most adult examples the little triangle is emphasized and tightly closed. In *intermedius*, type of the genus, the triangle is well developed, being practically closed in Nos. 174431 and 174432, but opening posteriorly in the right molar of No. 174425.

Summarizing, in *longicaudus* an outer triangle on the third lower molar is never isolated in the sense of being tightly closed. In the subgenus *Phenacomys* there is a tendency for an outer triangle to be isolated in this manner.

## 2 EXTERNAL CHARACTERS

### (1) General coloration

While certain young examples (notably Nos. 137, 138, 139, Univ. Oreg. Mus.) are somewhat paler than the rest, the entire series of thirty-three skins before me is remarkably uniform in general coloration, being cinnamon dorsally, paling to light ochraceous-buff on the sides, and becoming white ventrally. Tail usually colored a very dark brown, near seal brown, with no demarcation between dorsal and ventral coloration.

### (2) Dorsal coloration

A rich cinnamon, the exact hue varying from near orange-cinnamon (as in No. 21149, a specimen of middle age) to near ochraceous-buff (as in No. 19980, a very young specimen). The majority of the specimens are cinnamon or pinkish cinnamon on the back, and all have a greater or less insprinkling of spiny black hairs, which tend to give a darker appearance than would otherwise be the case. Eight young examples are quite close to No. 19980 in coloration.

The hairs of the contour pelage are deep plumbeous basally, the lighter portion of the shaft being confined to the tip. On nose and around eyes the hairs are shorter and lack the plumbeous bases. In most of the specimens the short hairs on the extreme tip of the nose are near light seal brown. Whiskers silvery or blackish brown, the silvery hairs often having blackish-brown bases. The combination of short ears and rather long hair makes the ears inconspicuous. In some specimens (notably Nos. 19985, 21145, 19984, 19975, 19980, 19978) the ears are almost concealed. In all examples the long hairs of the body pelage overlie the opening into the ear. The pinna of the ear itself is very thinly haired, within and without, with hairs similar in coloration to those making up the contour pelage of the body, except that there is a tendency for the plumbeous bases to be absent. Toward the base of the pinna the typical body pelage is encountered.

Forefeet dorsally with a shade of the buff or cinnamon series somewhat paler than that of the dorsal coloration, ordinarily white on the fingers, but sometimes washed with very pale buff; ventrally white; palm naked; hairs about bases of claws exceeding claws in length. Hind feet whitish, washed with



buffy on toes dorsally, as in No. 19174; or having black hairs insprinkled and a darker shade of buffy, as in Nos. 19974 and 19983; hairs about bases of claws often exceeding claws in length. Sides of body paler than back; the spiny black hairs fewer in number. In a typical example (No. 19174) the color grades from near orange-cinnamon dorsally to light ochraceous-buff laterally.

The peculiarities in coloration of a specimen collected at Meadows, Lane County, Oregon, have already been commented on in the literature (Miller, 1897a, p. 85; Merriam, 1901, p. 126; and see below, p. 131).

#### (3) Ventral coloration

White, sometimes with plumbeous bases of hairs showing through to some extent, often with the faintest possible wash of buffy. In adult females the positions of the two pairs of abdominal mammæ are marked by sparsely-haired circular patches a quarter to one-half inch in diameter. Hairs of throat and of nipple patches have no plumbeous bases. Sometimes hairs posteriorly on belly in vicinity of nipple patches also lack plumbeous bases.

Tail varying in coloration, in different examples, from pinkish-cinnamon to blackish-brown. Although there is in some specimens the faintest possible tendency toward ventral paling, in a large majority there is no discernible difference in coloration between the upper and lower sides. Most of the series have the tail tipped with a pencil of blackish-brown hairs. In No. 21153 all the tail except the tip is pinkish-cinnamon. Consequently the blackish-brown tip is very conspicuous. Ordinarily the general tail coloration is so dark that no contrast is observable.

#### (4) Length of tail

Miller (1897a, p. 79), in his key to the genus *Phenacomys*, sets off *longicaudus* as having a tail forty per cent of its total length, while the remaining species, including *ungava*, *latimanus*, *intermedius*, *preblei*, and *orophilus*, are grouped as having tails only twenty-five per cent of total length.

An examination of the available series of thirty-seven specimens of *longicaudus*, in connection with the study of the other examples of *Phenacomys* at hand and of all published measurements, enables the writer to confirm the validity of this

grouping. Of the series of *longicaudus*, No. 19985, a young adult, has the tail 44.2 per cent of its total length. No. 19976, also a young adult, is next, with the tail 42.5 per cent of total length. The largest and oldest individual of all, No. 19984, follows with tail 42.4 per cent total length. The smallest and youngest example of *longicaudus* measured to date (No. 20657, preserved in alcohol) has tail only 25.7 per cent of total length. Young animals are all characterized by low ratios, and as the scale of age is ascended the ratio increases.

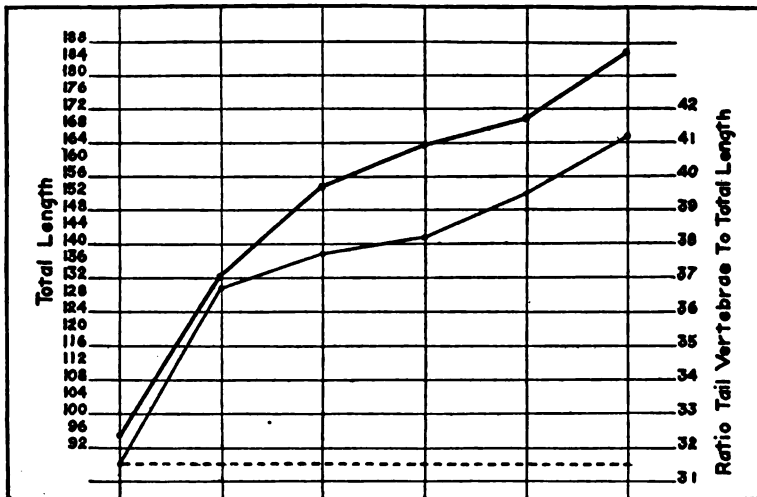


Fig. 3—INCREASE IN RATIO OF LENGTH OF TAIL VERTEBRÆ TO TOTAL LENGTH WITH AGE.

The heavy black line represents the actual total length (correlated with age); the light black line the ratio of the length of the tail vertebræ to total length. Each round dot represents the average for six individuals. The pair of dots on each vertical line pertain to the same six individuals. Read scale for actual total length on the left side of the diagram, and scale for ratio of the length of the tail vertebræ to total length on the right side. Note that if the ratio of the length of the tail vertebræ to total length remained constant with increasing age at the figure for the smallest group, the ratio would be indicated by a horizontal line, as dotted in the figure. But instead of this, the ratio undergoes a steady increase with age.

Of the other species of the genus, *P. albipes* makes the nearest approach to *P. longicaudus*, the two known specimens of this form having ratios of tail vertebræ to total length of 36.9 and 40.0 per cent respectively. Three skins of *P. inter-*

*medius* at hand (Nos. 174431, 174425, and 174432, U. S. Nat. Mus.) show ratios of 28.6, 34.3, and 29.3 per cent respectively; while two skins of *orophilus* (Nos. 109103 and 109102, Biol. Surv. Coll.) show ratios of 30.5 and 28.1 respectively. Of thirty-six specimens, representing eleven different species of the subgenus *Phenacomys*, the measurements of which are recorded in the literature, in only two does the ratio exceed 26.0 per cent, and in the majority it falls below 25.0. More

B External measurements of three species of the genus *Phenacomys*  
(All measurements in millimeters)

Museum No.	Sex	SPECIES AND LOCALITY	Total length	Tail vertebrae	Hind foot	Ratio tail vertebrae to total length
Phenacomys albipes						
97236	♂ ad.	California: Humboldt Bay (Arcata —in redwoods) .....	168	62	19	36.9
797	♂ ad.	Vida, Lane Co., Oregon.....	165	66	19	40.0
Phenacomys orophilus						
109103	♂ ad.	California: Tuolumne Meadows....	154	47	18	30.5
67327	♂ old ad.	Montana: Bear Tooth Mountains..	142	33	17	23.2
110249	♀ yg. ad.	California: Mt. Lyell .....	153	41	17	26.8
110251	♂ yg. ad.	California: Mt. Lyell .....	121	28	17	23.1
23849	♂ yg.	Idaho: Salmon River Mountains..	120	28	18	23.3
109102	♀ yg.	California: Tuolumne Meadows....	114	32	16	28.1
Phenacomys intermedius						
174431	♂ ad.	Alberta: Head of Smoky River....	98	28	19	28.6
174425	♀ ad.	British Columbia: Moose River....	105	36	19	34.3
174432	♀ ad.	Alberta: Head of Smoky River....	106	31	19	29.3

than that, the average ratio of thirty-one additional specimens, representative of the subgenus *Phenacomys*, falls below 26.0 per cent. These specimens constitute all of which measurements have been found by the writer in the literature.

Miller (1896, p. 24) asserts that length of tail in the *Microtinae*, being more unstable than certain other characters because more readily modified to fit a species to special requirements of its environment, is less important than these other characters in the diagnosis of subgenera. It would seem to the writer, however, that such a marked difference as seems to hold in this respect between the *albipes-longicaudus* group on the one side and the other species of *Phenacomys* on the other should be regarded as of at least subgeneric value.

## (5) Tuberculation of feet and the number of mammæ

A young example of *Phenacomys longicaudus* (No. 20658), preserved in alcohol, has five tubercles on the fore feet; the reduction of the thumb to a small tubercle makes the fore feet appear to have an additional tubercle. The hind feet are six-tuberculate.

*Longicaudus* has two pairs of mammæ placed far back on the belly. The only reference to the number of mammæ in the genus *Phenacomys* which I have been able to find in the literature is that of Miller (1897b, p. 22), in which a female of *P. latimanus* is stated to have eight mammæ, four pectoral and four inguinal. A difference in number of mammæ may characterize the two subgenera.

(6) The type of *Phenacomys longicaudus* True

This specimen has been several times described and the condition of its skull commented on (True, 1890, p. 303; Miller, 1897a, p. 85; Merriam, 1901, p. 126; Lyon and Osgood, 1909, p. 96). Tooth pattern in No. 19974 of our series from Mendocino City practically the same as in the type; and external characters show clearly that specimens in our collection are almost identical with the type.

## (7) The specimen from Meadows, Lane County, Oregon

Miller (1897a, p. 85) has described the aberrant specimen from Meadows, Lane County, Oregon (♀, No. <sup>20649</sup><sub>42821</sub> U. S. Nat. Mus., Biol. Surv. Coll., taken April 13, 1891), in the following words: "Head, back and sides pale yellowish drab, the fur light bluish plumbeous at base and sprinkled with inconspicuous dark hairs; belly grayish white, the bluish bases of the hairs showing through irregularly; tail indistinctly bicolor, light slaty gray above and at tip, whitish mixed with gray below; feet silvery white." Merriam (1901, p. 126) refers to the same specimen as being pale buffy fulvous, and remarks that it seems to be a partial albino.

## (8) Pelages

Specimens are available representative of every month in the year except September and December. Examples with the longest hair were collected during the winter months (notably No. 19130, taken January 6, and No. 19174, March 27).

The shorter the pelage the greater is the tendency for the plumbeous bases of the hairs ventrally to show through, consequently differences in length of pelage are more readily perceptible below than they are above. Applying this test to our series of *P. longicaudus* it is noted that spring and summer skins tend to have shorter pelage than those taken at other times of year.

No. 21143, collected April 20, has the pelage comparatively thin. Ten specimens, taken October 24 and 25, are not conspicuously different from those collected in July.

There is a not readily tangible tendency toward paleness in the summer skins. The slightly darker shade noted in the winter examples is apparently due to the longer cinnamon tipping rather than to any real difference in hue.

No molt lines or other indications of molt, aside from the slight difference in length of hair, are observable. Whether there is a definite time of molt cannot be stated. It is not improbable that there is a gradual hair renewal late in the fall, perhaps during November, and that the "summer pelage" is simply the worn winter pelage remaining over from this molt.

#### IV RELATIONS OF *Phenacomys albipes* TO THE TWO SUB-GENERA OF *Phenacomys*

The complex of its characters relates *Phenacomys albipes* more closely to *P. longicaudus* than to any other known form of the genus, as was implied by Merriam in the original description (1901, p. 125). For thirteen years the type specimen of *albipes* remained unique, and it is only recently that a second specimen has been collected (see Jewett, 1915, pp. 37-38).

Cranially *Phenacomys albipes* stands off by itself. Its skull, as compared with that of *orophilus*, *intermedius*, and *longicaudus*, has an appearance of length and narrowness (see Plate 15). Testing by actual measurement we find that there is no clear dimensional difference in greatest length (see tables of cranial measurements), *albipes* being exceeded by four of the nine specimens of *longicaudus* measured, and by three of the four specimens of *orophilus* measured. The zygomatic arches, however, do not spread so widely in *albipes* as in *longicaudus*, *orophilus* or *intermedius*. In fact, this dimen-

sion, as given in the tables of measurements, is less in *albipes* than in any specimen of these species measured, with one exception, an example of *intermedius* (No. 174431), in which the dimension is the same as that in *albipes*. In width of

C Cranial measurements comparative of  
*Phenacomys (Arborimus) albipes* and *Phenacomys (Phenacomys)*  
*intermedius*

(All measurements in millimeters)

(All measurements in millimeters)						Width of cranium outside external auditory meatus
Museum		Species	Greatest length	Zygomatic width	Interorbital constriction	
No.	Sex					
Phenacomys albipes						
97236	♂	.....	25.6	13.8	3.3	11.3
797	♂	.....	25.1	.....	3.7	11.2
Phenacomys intermedius						
174431	♂	.....	23.8	13.8	3.7	11.0
174425	♀	.....	24.9	14.2	3.6	11.0
174432	♀	.....	24.3	14.3	3.7	11.1

interorbital constriction one specimen of *albipes*, No. 97236, agrees with *longicaudus*, while the other, No. 797, is closer to *intermedius* and *orophilus*; in width of cranium outside of external auditory meatus the examples of *albipes* are less than those of *orophilus* but greater than those of *intermedius*. Eight of the nine comparable specimens of *longicaudus* exceed *albipes* in this measurement.

Back upper molar in *albipes* has the outer portion of the posterior crescent closed off to form a second outer triangle. In the type (No. 97236), the second outer triangle is closed off from the inner portion of the crescent in this tooth on both sides. In the second specimen (No. 797), there is a tendency for the second outer triangle on the left hand side to open very narrowly into the interior part of the crescent. In this character *albipes* is closest to *longicaudus*. The inner loop is intermediate in position and outline between *orophilus* and *longicaudus*, tending, in No. 97236, in the direction of *orophilus*, and in No. 797 in the direction of *longicaudus*. Whereas in the type (No. 97236) the triangles and loops of the front lower molar are for the most part closed off from one another, in No. 797 they tend narrowly to intercommunicate. The tight closure of these loops and triangles is observed often in, if not characteristic of, the subgenus *Phenacomys*,

whereas the open condition is typical of *longicaudus*. Antero-external loop of second lower molar as in *longicaudus*. Outer triangle on same tooth moderate in size, often opening very narrowly forward or back, practically intermediate in condition between *longicaudus* and the *orophilus-intermedius* series. Back lower molar as in *longicaudus*.

In coloration dorsally and laterally *albipes* has been described as "grizzled bister" differing from the grayish or light brownish *orophilus-intermedius* series in being darker, and from *longicaudus* in being browner. Its general aspect is much like that of *Evotomys californicus*. The coloration of the lighter hairs is of a tint a little paler than the cinnamon of *P. longicaudus*, from which *albipes* differs markedly in having a much larger proportion of black hairs. Laterally there is an inconspicuous paling, the result of a slight increase in the number of hairs of a cinnamon or buffy hue. Ventrally *albipes* is white, as in *longicaudus*, but with a faint wash of buffy, as in *Evotomys californicus*. Feet white. Tail sharply bicolor, "dusky" above and "broadly whitish" below. The tail is also longer than in any other species of the genus except *longicaudus* (see p. 129, above).

As may be inferred from the fact that only two specimens of *albipes* have been taken to date the habits of the form are practically unknown. Dr. Walter K. Fisher, who collected the type specimen, informs the writer that the type was taken in a trap set close to the base of a redwood perhaps two feet in diameter, which formed one of a clump. The trap was set on top of a small rotten log, which leaned against the tree and was covered with "needles." The clump was made up of second growth redwoods and the general surroundings were dry. The second specimen (Jewett, 1915, p. 38), was collected among rocks at the side of a small stream where it flows through a dense forest of spruce and fir timber. At this point both banks of the stream were lined with an almost impenetrable jungle of salmon-berry bushes and sword fern, where jumping mice and deer mice, as well as several species of shrews, were collected. Thus there is no evidence of any arboreal habit in *Phenacomys albipes*.

Summarizing, it should be noted that *Phenacomys albipes* resembles *P. longicaudus* in that there is present on the back

upper molar a second outer triangle, which is practically closed off from the inner loop, the antero-external loop on the second lower molar is open, the enamel pattern of the third lower molar is nearly identical, the geographic range is similar, and the proportionate length of the tail is nearly the same. It differs from *longicaudus* in being darker, in having a faint wash of buffy on the white ventral surface of the body, in its bicolored tail, in the general length and narrowness of its skull, and in its, so far as known, exclusively terrestrial habit. It is practically intermediate between the *orophilus-intermedius* series on the one hand and *longicaudus* on the other in width of interorbital constriction, outline and position of postero-inner loop on back upper molar (closer to *longicaudus* than to the *orophilus-intermedius* series in this character), and outline of outer triangle on second lower molar (perhaps closer to the *orophilus-intermedius* series in this character).

There are several alternatives open in the matter of the disposition of *Phenacomys albipes*. It may be left "of uncertain status"; it may be accorded separate subgeneric rank; or it may be referred to one or the other of the subgenera *Phenacomys* and *Arborimus*. In view of the small amount of material available, there is much to be said in favor of leaving it for the present "of uncertain status." The peculiar slender appearance of its cranium might be regarded as of separate subgeneric value, if it were more striking, or if there were associated with it other characters of importance. Since most of the available evidence seems to point to the disposition of *albipes* as a member of the subgenus *Arborimus*, the species has been assigned thereto by the present writer, but in the absence of more material and information it is emphasized that such reference must necessarily be no more than tentative.



## D DISTRIBUTION AND HABITS OF *PHENACOMYS LONGICAUDUS* TRUE

### I DISTRIBUTION

#### 1 IN TIME

No fossil material whatever referable to the genus is known. "*Arvicola intermedius* Newton (see Miller, 1896, pp. 75, 76) from the late Pliocene Forest Bed of Norfolk, England, referred to *Phenacomys* by Nehring, has recently been associated with a number of other fossil forms in the genus *Mimomys* Forsyth Major. As stated by Hinton with reference to the genus *Mimomys* (1914, p. 474), "its members are amongst the earliest microtines in Britain, having been detected in the late Pliocene Norwich Crag." Consequently this genus is of great interest, although its generalized enamel pattern with reëntrant angles approximately equal shows that it cannot be closely related to *Phenacomys*.

#### 2 IN SPACE

Specimens have been actually taken as follows: In Oregon: Marshfield, Coos County; Meadows, Lane County; Eugene, Lane County. In California: Chaparral Mountain, above Maplecreek Post Office, near "Big Bend," Mad River, Humboldt County; Cuddeback, Humboldt County; Carlotta, Humboldt County; Mendocino City, Mendocino County; Lierly's Ranch, four miles south of Mt. Sanhedrin, Mendocino County.

There is little doubt that the tree mouse occurs at many other localities in this general region. Mr. Aurelius Todd,

Fig. 4—KNOWN RANGE OF *PHENACOMYS LONGICAUDUS*, WITH RECORD STATIONS OF ALL THE *PHENACOMYS* KNOWN TO HAVE BEEN TAKEN IN CALIFORNIA AND OREGON.

(See map on opposite page.)

- Localities where *Phenacomys orophilus* has been collected
- ▲ Localities where *Phenacomys albipes* has been taken.
- Localities where *Phenacomys longicaudus* has been collected.
- ⊗ Localities where *Phenacomys longicaudus* is known to occur, but no specimens collected as yet.
- ▣ Area within which *Phenacomys longicaudus* is known to occur.

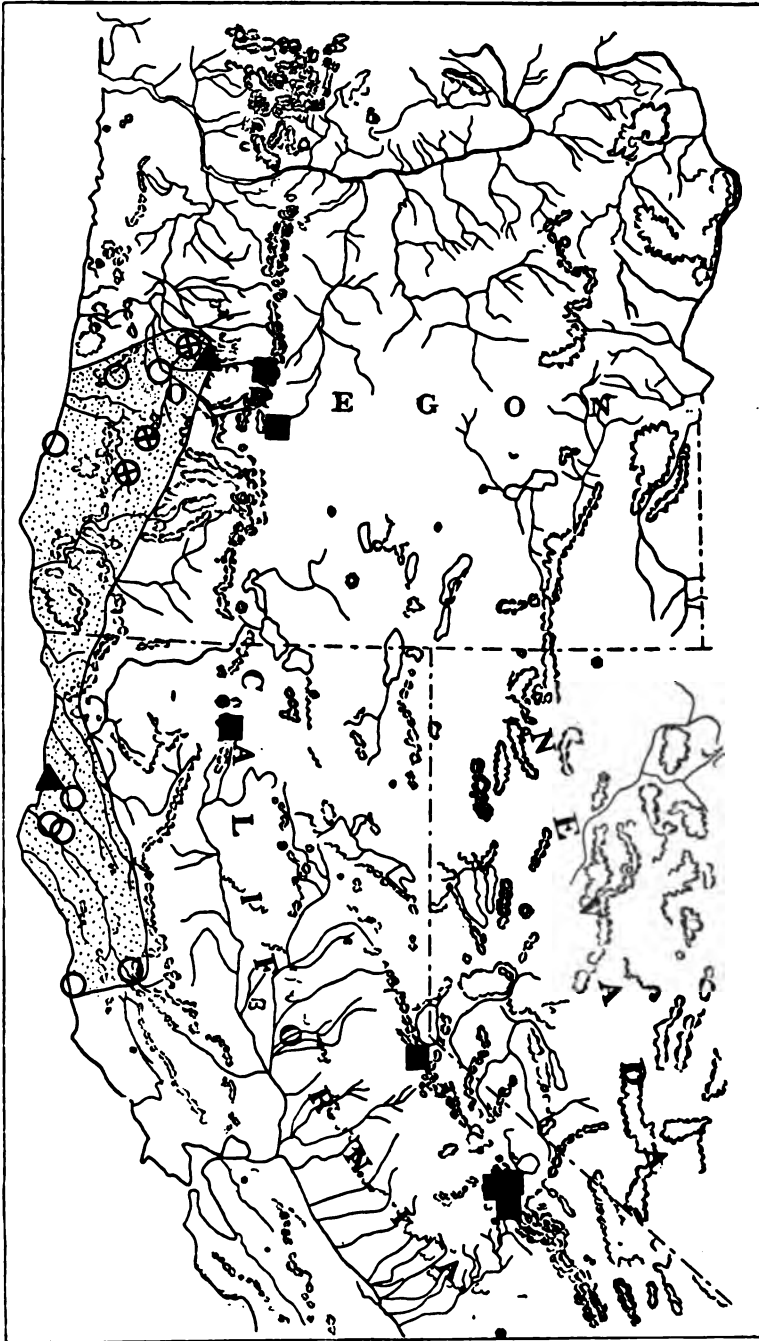


FIG. 4 (See caption on opposite page.)

to whom credit belongs for first calling the attention of scientists to the species, asserts (1891, p. 241) concerning its occurrence: "My first discovery of this animal was in June, 1886, in the valley of Elk Head, on the headwaters of Elk Creek, a tributary of the South Umpqua River, and some seven miles east of Voncalla, Douglas County [Oregon], while out looking for birds' nests . . . . I have . . . found their nests down Elk Creek, along the Coquelle River, in Coos County, in southern Douglas County, and also on the upper Willamette tributaries, in Lane County, and believe it will yet be found in Washington and perhaps through the whole of the northern coast." Maps of Oregon, which the writer has examined, show two Elk Creeks tributary to the Umpqua River. Elk Head is located on the Elk Creek tributary to the main river, not tributary to the South Fork of the Umpqua. Voncalla is spelled Yoncalla on recent maps (1908, 1910), and Coquelle is rendered Coquille on the same maps.

In the original description of *Phenacomys longicaudus* (True, 1891, pp. 303-304) there is quoted a letter from Todd in which is contained the only reference I have seen to the occurrence of the tree mouse in Curry County.

Mr. Alfred C. Shelton, field naturalist of the University of Oregon, tells me that he has located colonies in the vicinity of Mabel, Lane County, and Melrose, Douglas County; while Mr. C. I. Clay, of Eureka, California, writes that on June 16, 1915, he observed a number of *Phenacomys* nests along the road between Ferndale and Capetown, on the ridge just north of Cape Mendocino and very close to the coast.

Upon this showing it is not unlikely that the species is far more abundant and widespread than the examples now contained in museums would indicate.

## II HABITS

### 1. GENERAL HABITAT

Characteristically, perhaps exclusively, arboreal. That the tree mouse ever comes to the ground of itself for the purpose of subserving its own specific economy remains to be demonstrated. In Todd's letter of transmittal which ac-

accompanied the shipment of the first specimen it is asserted that so far as could be found out, *Phenacomys longicaudus* lives exclusively among the boughs and branches of *Abies douglassi* (= *Pseudotsuga taxifolia*). Farther on Todd modifies this statement by remarking that tracks, which he thought were made by these little animals, had been seen in the snow around the trees. "They could be tracked," says Todd, "up and down the tree, but to no great distance from it, and were most likely in search of food." In a contribution to the West American Scientist (1891, p. 242) Todd again calls attention to the tracks he has seen around the trees, but specifically disclaims positive knowledge that they were made by *Phenacomys*.

Wilder gives it as his opinion that they must occasionally come to the ground, though it is to be doubted whether they spend much time there.

Clay says that in order to reach the tree containing the family nest, the males in some instances would have to descend to the ground. This is on the theory (see p. 153) that males live for at least a part of the time in small nests separate from those of the females.

All the clear evidence at hand shows that tree mice are dependent on the trees in which they live for food, home and drink. I have not seen nor can I find any record of any object found in any nest of *Phenacomys* indicating that it visits the ground. All nests at Mendocino City were found in grand firs (*Abies grandis*). The only piece of nest material not derived from this tree was a twiglet of Bishop pine (*Pinus muricata*), which was probably brought in by way of the tree branch route.

## 2 KINDS OF TREES INHABITED

Nests of *Phenacomys longicaudus* have been found in three conifers, *Picea sitchensis*, *Abies grandis* and *Pseudotsuga taxifolia*. Our field party in 1913 found nests in both the latter-named species, those at Mendocino City being in grand firs, while those at Lierly's and elsewhere were in Douglas firs.

So far as Todd was aware (1891, p. 240) the tree mouse was found only in the branches of the Douglas fir. In fact, all published records of nests which I have seen refer to their

occurrence in this tree alone. Clay reports that although the Douglas fir seems to be preferred, he has found many nests in the lowland (or grand) fir in the Mad River country (Humboldt County, California), and has taken several from the Sitka spruce. His record of nests in the Sitka spruce are so far unique.

It is quite probable that the larger numbers and general availability of the Douglas fir in the area of occurrence of the tree mouse have much to do with the observed occurrence of most of the nests in trees of that species.

### 3 COLONIAL TENDENCY

Although Wilder says that he has never found the *Phenacomys* in Humboldt County nesting in colonies, the experience of other investigators in other places shows that there is a pronounced grouping tendency observable. At Mendocino City, for example, our party made studies of two groups or colonies of nests, and all nests observed later exhibited a similar colonial arrangement. It should, however, be stated that in no case were the nests *closely* grouped, though they were located in the same general section of forest. Clay asserts that they live in colonies as a rule, although they spread to isolated positions in individual cases, and cover a vast expanse of territory.

One colony studied at Mendocino City was located on a flat north of town, in a grove of tall *Abies grandis* intermixed with scattering Bishop pines. The second was found on the side of a ravine a little farther to the north. Here, although the grand firs formed an almost pure stand, there were a few Douglas firs and an occasional Bishop pine. Examples of *Phenacomys* were taken in both these colonies.

Another colony was later located in large Douglas firs in an isolated position on the south-facing slope of a small hill, near the Eden Valley road, four miles north of Hearst, Mendocino County, California. A group of nests resembling those of gray squirrels, and possibly now belonging to *Phenacomys longicaudus*, was also encountered in a grove of Douglas firs about 500 feet above the South Fork of Eel River, and a mile distant therefrom, on the north side, four miles east of Hearst. Shortness of time did not permit of its examination.

Still another colony was found in the Douglas firs immediately south of Lierly's Ranch, four miles south of Mount Sanhedrin, Mendocino County, California. One tree mouse was here secured.

At Mendocino City thirteen nests were carefully examined. In eight of these animals were actually found. In the first colony there were about a dozen nests; in that on the side of the ravine, seven or eight. The colony north of Hearst contained about the same number, while at Lierly's there were more, although some of the nests observed in that locality may have belonged exclusively to *Sciurus griseus*.

#### 4 OBSERVED MOVEMENTS

*Phenacomys longicaudus* does not seem to possess any extraordinary agility, quickness, or aggressiveness of movement. Wilder says the mice are quick to leave the nest when the latter is disturbed, and remarks that while sometimes they are caught in the nest they are more easily caught on the ground, where, although not really slow, they are a little clumsy. Shelton relates an instance where a tree mouse left the nest just as the observer came on a level with the structure. It ran out to the tip of a branch and was there secured by means of a shot pistol. The same observer records an instance of the frightening of a *Phenacomys* from its nest, the animal showing remarkable agility, going from tip to tip of the fir boughs with speed and ease, and so running from tree to tree until finally it escaped into the branches of an old cedar (*Thuja plicata*), the fourth tree from the nesting site. This record of remarkable agility was not borne out by our observations, according to which the animals ran rather slowly and uncertainly along the twigs on which we saw them, and seemed on the whole rather slow-moving. Several were caught with the bare hands in the trees. One tree mouse, which reached the ground, exhibited more speed there than any we saw in the trees. It is quite possible, though on this point there is no evidence, that *Phenacomys longicaudus* is strictly nocturnal and is bewildered by the light of day.

The unwillingness of the tree mice to leave the nest was quite evident. Ordinarily the occupants would remain until much of the structure had been dissected away. In one

instance an adult female and a half-grown young individual were taken from the *last double handful* of the nest-mass remaining in the tree.

The tree mice when caught did not ordinarily defend themselves with energy, although one young individual seized a finger of its captor and bit hard enough to draw blood.

#### 5 VOICE

Wilder asserts that when individuals of *Phenacomys longicaudus* are caught they utter a mouse-like squeak. Only one of those taken by us was heard to utter a sound. This was a juvenile individual which, upon being seized, squeaked plaintively.

#### 6 FOOD AND DRINK

At Mendocino City we always found green twigs on and in occupied nests. The leaf of a grand fir was found in the mouth of one individual, and the stomachs and intestines of all those examined were brilliant green. Microscopic examination of cross-sections of the fir needles discloses the fact that all the fleshy substance of the needle including the vascular bundles is eaten away by the tree mouse, the only portions left being the two resin ducts which traverse the entire length of each needle. These filamentous resin ducts have quite naturally been mistaken for midribs by some observers. The outer or cortical portions of young shoots are also used as food, in this case resin ducts and all being eaten. It is probable that the chief food of the species is derived from the needles and young shoots.

In a colony on Chaparral Mountain, on the slope above Maplecreek Postoffice, Humboldt County, California, which was studied by Clay, the top of practically every inhabited tree was dead. Many nests were found by locating the dead-topped trees. "The nest was sure to be there," says Clay, "and was always inhabited." In some cases in which the nest was low in the crown of the tree and far out on a limb, the bark would not be touched, but in the dead-topped trees small runway-like trails were noticed over the trunk where the bark had been stripped away. Sometimes these trails ran together making a wide exposed place. The tree was cut

always at the exact level of the nest, or the point of junction of the nest-limb with the tree. "Many trees were bushed out at the top as though they had been cut, rotted off . . . and then taken sprout; some bushing out, some forking, and some growing up in a deformed top." Examination of these disclosed furrow-like ridges in the bark, where Clay concludes the trees had been cut many years ago. Tooth marks were plainly visible in some of the more recently stripped places, so that Clay is certain the cutting is done by *Phenacomys*, though he does not know whether the bark is eaten or not.

Because of the dead tree-tops, the semi-isolated nature of the grove in which it was located, and the age of the nests, it was concluded that this colony was a very old one. It is implied, furthermore, though Clay does not permit himself to make a positive statement in this regard, that only the trees containing old nests or which had been inhabited for a long time showed the phenomena of the dead tops. The absence of dead-topped trees in the vicinity of Carlotta where nests were studied by Wilder is explained on the supposition that *Phenacomys* occupation in that neighborhood has been of comparatively short duration; and the additional suggestions are tentatively propounded, that large trees are not subject to the attacks to which the smaller ones are liable; that possibly the tree mice feed on bark only intermittently; or that it may be that the bark of older trees is not palatable. It seems that the Chaparral Mountain colony was located in small firs, while occupied trees at Carlotta are of larger size.

Although it must be admitted that the circumstantial evidence submitted by Mr. Clay is strong, still it ought to be remembered that bark damage and tree destruction by *Phenacomys longicaudus* is unconfirmed to date by any other observer, and it is possible, if not probable, that phenomena due to some other local cause or condition on Chaparral Mountain have been erroneously associated with the tree mouse.

One animal kept by Mr. Clay in captivity would not eat grain, grass, or meal, finally dying apparently for lack of proper feeding.

The area of occurrence of the tree mouse falls for the most part within the humid coast province or faunal area, a region characterized by frequent fogs, high relative humidity of the



air, and moderately heavy rainfall. It is quite probable that the animal's need of moisture is supplied by the water which gathers on the foliage of the trees in which it lives, if, indeed, it needs more moisture than is contained in its food.

#### 7 HOME RANGE OF THE INDIVIDUAL

The fir trees in which our party found colonies of *Phenacomys longicaudus* were close together, and transit from tree to tree by way of the foliage route would be comparatively easy. In one nest a branchlet of Bishop Pine (*Pinus muricata*) was found, as has already been noted. This could only have been brought in by the tree mouse or some other animal. It will be remembered that Shelton (see page 141 above) noted a mouse traveling from tip to tip of the fir boughs, quickly escaping in a *Thuja plicata* which was the fourth tree from the nesting site. It is not improbable that the tree mouse ranges freely through the foliage of several trees in the vicinity of his home nest tree.

#### 8 HIBERNATION

Wilder suggests the possibility that the tree mice may hibernate in the cold region back from the coast, and records finding one in February, presumably at Carlotta, Humboldt County, California, curled up and dormant. The same day, however, he found two females with half grown young; so he concluded that the first must have been chilled into temporary inactivity by the storm just ended. Todd (1891, p. 242) suggests that the tree mice probably do not hibernate, on the basis of the tracks seen about the nest trees in the snow. But allusion has already been made to his uncertainty as to whether or not the tracks were those of *Phenacomys longicaudus*.

It is doubtful whether the cold weather is severe enough in the area of occurrence of *Phenacomys longicaudus* to make true hibernation necessary, although there may be inactivity during the colder periods. The writer has been unable to find any definite records of hibernation among the *Microti*, although Barrett-Hamilton and Hinton (1914, p. 466) refer to the inactivity during cold weather of *Microtus orcadensis sandayensis*. Bailey definitely asserts (1900, p. 6) that no American species of *Microtus* is known to hibernate.

## 9 STUDIES OF THE NEST

## (1) Altitude above the ground

The height of nests above the ground, varying as it does from four feet to one hundred feet, testifies to the freedom of movement of *Phenacomys longicaudus* in its arboreal habitat. Wilder writes that he has found several nests low enough in the trees to be reached from the ground. Shelton records the examination of a nest a hundred feet up. In Clay's experience eight and 100 feet are the extremes, with the prevailing height at 20 to 60 feet. Nests observed by our party ranged in altitude from eight to 60 feet.

## (2) Position in trees

A majority of the nests are located against or around the trunks of the trees. All those observed by Shelton in Oregon were situated next the trunk of the fir, where they were securely supported by one or more branches. Wilder asserts that in his experience most of the nests were located where several limbs join the trunk, although where nests have been found on large trees they have usually been near the ends of lower branches and at no great height above the ground.

Clay says that low nests are usually near the outer end of a drooping limb, but agrees that most nests are placed near the trunk of the tree.

All nests actually examined by our party at Mendocino City were built near the main trunk of the fir where a circlet of branches joined the tree, although we noted at least two nests on limbs several feet distant from the main trunk. In several instances the nest was built all around the trunk, so that the trunk actually traversed the center of the nest.

## (3) General size

Todd (1891, p. 241) says the nests are about the size of robins' nests, or even smaller. Shelton has examined a nest only eight or ten inches in diameter, the largest nest he has seen being about two feet in diameter by one in depth. Wilder asserts that when the nests are new they are about the size of a quart measure, old nests being larger, sometimes as large as a peck measure.

According to Clay the family nests were from nine to 12 inches in diameter in new structures, up to 30 inches or more across and 12 inches or more deep, in the older ones.

Nests observed by our party varied in dimensions from about 18 inches in length, breadth, and height to three feet in diameter and two or three feet in height, enormous structures when it is remembered that the maximum total length of the mouse is only about seven and one-half inches.

(4) Skeleton, form and makeup

(a) Possible parasitism of *Phenacomys longicaudus*

All nests observed by members of the Museum party in the vicinity of Hearst and Lierly's Ranch were apparently the appropriated nests of *Sciurus griseus griseus*, many of the sticks used in their construction being too large to have been carried by the tree mice. Shelton reports that he has found, in the course of his investigations in Oregon, only one nest of original *Phenacomys* construction, all others being old and remodeled nests of the gray squirrel.

All nests examined by us at Mendocino City, however, were probably built by tree mice exclusively, since there were no sticks used which were too large to be handled by them alone.

An interesting question arises as to the occupation of the gray squirrel's nests by *Phenacomys*. Does the tree mouse parasitize and finally drive out his larger arboreal neighbor, or does the mouse appropriate the nest only after its abandonment by the gray squirrel?

(b) Form and composition of the nests

Although one's first impression of those nests studied at Mendocino City was that they were loosely built, it was soon discovered that they were steadily fastened and rather difficult to dissect. Usually the structure was spherical in form with a slight flattening on top. Often the flattening was so pronounced as to make the nest hemispherical in form. The skeleton of the nests was formed entirely from twigs of the grand fir (*Abies grandis*). As used in the nest mass these twigs were dry and leafless. Making up a close interpacking was much material composed of the net-like fibrous mat of the net lichen, *Ramalina reticulata*, and of the resin ducts of fir leaves, the latter material predominating. Piled up above the thick mass of the main nest there was always a loose superstructure of twigs and branchlets. Some of these were of considerable size for the small mouse, the largest being one-eighth inch in diameter and four to eight inches long.

Residents told us that green twigs on the ground beneath the fir trees indicated not only the presence of a *Phenacomys* nest but also the fact that the nest was occupied. Although this would not seem always to be so, since we found green twigs under trees in which there were no nests, it would appear to be the rule. At any rate, green branchlets were noted on the ground under most of the occupied nests we investigated; and it was true in all instances where the nest was occupied that fresh green fir branchlets were pulled into the loose superstructure of dry twigs on top of the nest.

Reference has already been made to the fact that the nests found at Lierly's Ranch and Hearst, Mendocino County, were made up of sticks too large to be transported by *Phenacomys*, so doubtless originally constructed by the gray squirrel (*Sciurus griseus griseus*) or the wood rat (*Neotoma fuscipes fuscipes*). The lone individual tree mouse taken at Lierly's Ranch was found 50 feet up in a Douglas fir, in a nest 18 inches in diameter, built of sticks of fir and lined with "tree moss" (really the net lichen, *Ramalina reticulata*) which appeared to have been fluffed up by the occupants.

Our studies of nests at Mendocino City showed that below the level of the used portion of the nest there was usually found a mass of decaying matter, sweating and steaming like a pile of old manure or like green feed in a silo, a very large part of the nest being made up of this material. In composition this mass was nothing more than the resin ducts of fir leaves and net lichen with quantities of feces distributed through it. Occasionally, but not often, this old slowly decaying matter was relatively dry.

Well defined galleries traversed the nests in various directions, providing ready communication between the inner nest cavity and the outer world. When the nest was built all the way around the trunk of the tree a circular gallery, running around the trunk and communicating with runways leading to the nest cavity and the exterior, was usually found.

Bailey (1915, pp. 148-149) says some *Phenacomys* houses had only one nest [inner nest cavity], and others had as many as five. Concerning one nest examined by him he says: "The twigs of which it was largely composed had settled in a half decayed and earthy mass as solid as a muskrat's house, and

beginning at the top a tiny burrow wound down spirally through the structure to one after another of the four or five fresh, clean little nests of green spruce leaf fibers."

Shelton has described several nests studied by him in the vicinity of Eugene, Oregon. One nest, found approximately 100 feet above the ground in a Douglas fir on Spencer Butte, seven miles south of Eugene, was about two feet in diameter by one in depth. It was composed of dry twigs and moss and was beyond all doubt the nest of a gray squirrel (*Sciurus griseus*) remodeled for *Phenacomys* use. The exterior of the nest was wet and mouldy, but the interior was dry and warm. The inner nest was spherical in shape, about five inches in diameter, and composed of fir needle fibers. The nest cavity was within this ball-like structure, and communicated with the outside through a small round opening about an inch in diameter in the wall of the inner nest. A mouse, after traversing this opening, would find itself in the coarse outer structure of dry twigs and moss, through which escape was possible in any direction.

Another nest, found in February by Bovard and Shelton, was located 30 feet up in a Douglas fir. This was a large nest, doubtless originally belonging to a gray squirrel. Its coarse outer structure was of large dry twigs and moss. Within was a large quantity of fibrous material, apparently from the inner bark of the tree, and within this was the inner nest proper, a round ball of the characteristic shredded fibers of the fir leaves. The outer structure was wet and mouldy, and the entire nest was heaped high with piles of rotting feces. In this nest there were taken two young animals, half or two-thirds grown. In the course of the investigation, the nest was entirely dissected away, and there remained nothing of it. Returning to the same locality in June, another nest was found in practically the same crotch. This was a small nest, only eight or 10 inches in diameter, composed of soft moss and the fibers of the fir needles. A small quantity of feces had collected. As Shelton remarks, the indications are that the adult mice, returning and finding their home destroyed, had started a new one of their own construction. Incidentally it should be remarked that this was the only instance noted by Shelton of a nest of original *Phenacomys* construction.

Wilder writes that he has found mud-masses in some of the nests, and that the foundation of a fresh nest recently examined by him was of small dry branches and mud balls. In mentioning these facts, he suggests that possibly the nests containing mud are built upon structures started by some mud-mason like the robin, or possibly a wood rat, which makes use of anything loose it can find.

More extended reference is made below (see page 153) to the possibility of the existence of two kinds of nests, "male" nests and "family" nests. Clay has submitted the following description of the supposed nest of the male: "The male nest is a neat, compact, round ball of small twigs, five to eight inches in diameter or possibly a little larger, well lined with the usual material, containing one entrance hole as a rule, the opening facing the trunk of the tree and usually being well hidden by foliage. The favorite location is one where the fir needles are thickest on the limb, some distance away from the trunk of the tree. Annual additions were not in evidence in any of the male nests examined. Ordinarily only one nest is to be found in a tree, but in several instances in which the family tree was isolated the male's nest was found in the same tree with the family nest. The nest of the male is always higher in the tree than the family nest, and is usually well concealed."

(c) The inner nest cavity

All inner nest cavities examined by us were lined either with net lichen or with the fine fir-leaf resin ducts. In spite of the humidity of the surroundings and the dank character of the nest mass below it, this inner nest appeared to be dry and comfortable. The finely shredded character of the material used for the inner nest guarantees its softness, and the thickness of its walls probably insures a certain degree of heat in occupied nests. It is even possible that the slow oxidation of the nest-mass, as indicated by the sweating nature of the material beneath the occupied nest cavity, is a source of heat.

The cavity of the nest at Lierly's Ranch from which the tree mouse was secured was 10 inches across. It was always necessary to dissect away much outer material before the inner nest could be found. Located in the upper part of the nest as a whole, it was in all cases covered over and well protected from the outside.

Residents of Mendocino City said the tree mice lined their nests with hair, but this we failed to confirm.

As remarked above, feces were found in quantity throughout the entire nest structure, except in the inner nest cavities, although a few feces are present in a mass of inner nest cavity material which was saved and brought to the Museum.

Even this much of a localization in the deposition of excrement is interesting, as it seems to indicate an early stage in the development of an instinct of sanitation.

(5) Large nests the work of years

Observations have already been made concerning the extremes of size displayed by different nests. For example, Todd records noting a structure the size of a robin's nest (1891, p. 241), or even smaller (in True, 1891, p. 304). Our party observed nests which were as much as two or three feet in height and three feet in transverse diameter. A significant point regarding these larger nests is that only their upper portions were in use.

Clay reports that the family nests showed signs of being renewed at least annually and possibly at even more frequent intervals. Deserted beds were found under or alongside those which were occupied. The type of branching at the point where the nest was located was a most important factor in determining the form of the nest. Some nests were built wide; in these the deserted inner cavities would be on a level with the occupied one. Others were built high rather than wide; in these the deserted beds would be superimposed one above the other. It seems clear that each nest becomes larger year by year. Apparently the discarded resin ducts of the fir leaves with the twigs remaining after the tree mouse has eaten off the fleshy portions of the leaves are immediately incorporated into the nest mass. This, in itself, would cause a continuous increase in size. Whether there is a new nest actually built on top of the old mass every year is unknown, but it is not improbable that some such regular addition is constructed.

(6) Desertion of nests

Under this head Todd (1891, p. 241) says: "For some reason which I have not been able to discover, these nests seem to be frequently changed or deserted, from the fact that

we frequently find in the woods and under lone trees of this variety, on the ground, small parts and at times almost, as it appears, the entire nest." Wilder says that the tree mouse seems to desert nests which have been disturbed, and has found a few nests apparently permanently unoccupied. Nearly all the nests examined by our party at Lierly's Ranch and at Hearst were apparently deserted or unoccupied. Animals were actually taken in eight out of 13 nests we carefully investigated at Mendocino City. Of the five nests we found to be unoccupied, some were doubtless deserted, while the dwellers in the others may have been out at the time of our visits.

Wilder has often noticed the disappearance of entire nests previously located. This together with Todd's record of finding portions of nests on the ground clearly indicates the presence of enemies of the tree mouse. Doubtless the small boy is at present the chief of these. Although there is nothing definite on this head Mr. Wilder suggests cats and horned owls as possible additional enemies. There is a possibility also that unusual gales of wind may occasionally dislodge the nests.

#### 10 BREEDING HABITS AND FAMILY RELATIONS

##### (1) Time of breeding and size of families

On July 15 and 17 we found young in three nests at Mendocino City. In each of two cases, there were two young, in one case a single individual. Shelton took two young from a nest at Spencer Butte, near Eugene, Oregon, on February 21. Wilder found a female and two half grown young in Humboldt County, California, during the same month, and asserts that the tree mice seem to breed all through the spring and summer. Clay opened four nests containing three young each, and says the breeding season seems to occur from the middle of April till late in the summer.

It may be that, like some species of *Microtus*, the young may be born at any season, but it is perhaps more probable that their birth is limited to late winter, spring and summer. Two pairs of abdominal mammae are borne by the females, which indicates that litters are small.

The young are evidently helpless for some days after being born, remaining for the time in the inner nest cavity. Young in three out of the four nests investigated by Clay had not yet opened their eyes.



## (2) Preponderance of females

Of all the sexed specimens of *Phenacomys* available 10 are males and 20 females. This preponderance of the females in series of *longicaudus* is impressive, and the question immediately arises, why should there be such a discrepancy in numbers of the sexes?

Segregating the specimens according to age, we find that of the eight adults, their age being determined on the basis of the degree of emergence of their cheek teeth, only two are males.

Twelve specimens of *Phenacomys orophilus* are equally divided between the sexes, there being six of each. Of four fully adult *orophilus*, one is a female and three males.

There are at least two possibilities to be considered: (1) that the mice are polygamous or promiscuous, and that there are actually more females than males; (2) that the female adults remain more closely in the nests than the males do, and are taken in greater numbers by our methods of capture, which involved the dissection of the nests.

It may be that both these possibilities are effective. Of the eight youngest examples at hand six are males and two females, but of all the young of *longicaudus* available, eliminating four alcoholics not sexed, eight are males and thirteen females. It appears that among the young individuals the proportion of females to males is well below two to one, while among the adults the proportion is four to one.\* If males and females are born in equal numbers the young, supposedly non-breeding individuals, should have divided up equally between the sexes. But since they did not, one is tempted to the conclusion that females are actually about twice as numerous as males.

On the other hand, the difference in proportions of females to males in the series of young and adults respectively seems to indicate that the females do remain more closely in the nests than the males and so were taken in greater numbers by the methods of capture employed.

*Orophilus* and *albipes*, being taken by free trapping on the ground, would probably not give the bias in the number of

\*The classification of the specimens into adult and young is an arbitrary one, and several of the examples classed as young probably are breeders.

females that the dissection of the nest would. In fact, since the males may be more active as foragers than the females, there might even be a disproportion of males.

### (3) Family relations

In each nest in which young were discovered there was one inner nest cavity and one brood of young. This would seem to indicate that only one family lives in each occupied nest. Possible evidence to the contrary was the capture of two seemingly adult males in a tree in which a nest was being dissected. It is not certain, however, that both these mice came from this nest.

Wilder says that he has several times found the female and young in a large nest, and the male in a small nest a few feet higher in the same tree. After remarking upon the difficulty he has had in finding males he suggests that it is possible they live in nests separate from those of the females, in the large trees, where their small nests would not be noticed, while the females for the most part select smaller trees.

Clay asserts that the male and female of a family do not live in the same nest during the rearing of the young, although it is probable that the males do seek the family nest thereafter. The small nest of the males would be likely, says he, to be destroyed by storms, necessitating the building of a new nest each season. On January 6, 1912, two adults were found in one nest, the one secured being a female. Clay suggests that the "escape" was a male, and that the incident would support the theory that the male and female live together during the winter months.

This most interesting suggestion of Wilder and Clay deserves further investigation. If it is in accord with the facts, there would be furnished an additional reason for the preponderance of females in our series; for the large family nests would be much more likely to be dissected than the small nests of the males. It seems to the writer that the evidence on this point of the separate nests for the sexes is inconclusive.

## E THE POSSIBLE ANCESTRY OF *PHENACOMYS* *LONGICAUDUS* TRUE

The known characters and distribution of the members of the genus would seem to support the theory that the subgenus *Arborimus* is derived from the subgenus *Phenacomys*, or that both subgenera are derived from a common ancestral stock not very different from either; and that the isolation of portions of the parent stock was an important factor in their differentiation.

It is furthermore possible if not probable that both *Phenacomys longicaudus* and *Phenacomys albipes* are descended from the same species, doubtless a member of the subgenus *Phenacomys*. Compared with *albipes*, *longicaudus* would seem to be a little more specialized. The two species may exemplify successive migrations of similar individuals from a common center, *longicaudus* being of the first wave, *albipes* of the second. *Longicaudus* would in this way have had time to become more specialized than *albipes*.

It is almost impossible to avoid the inference that the long tail in *Phenacomys longicaudus* and the arboreal habit are in some way associated.

Allen has recently shown (Bull. Amer. Mus. Nat. Hist., 34, 1915, p. 166) that the tail in different groups of tree squirrels is developed in proportion to their exclusiveness as tree dwellers, the ratio of tail length to total length varying in the different groups from about 40 to 52 per cent. Ground-living species of *Phenacomys* (except *albipes*) have ratios of 25 per cent, *albipes* (ground living) has an average ratio of 38 per cent, and *longicaudus* (tree dwelling) of approximately 40 per cent.

As implied above, it seems certain, from the close general similarity between the tree mouse and its ground living relatives, that the long-tailed arboreal species is derived from some short-tailed terrestrial form.

The possible connection between the long tail of *P. longicaudus* and its arboreal habitat suggests a train of puzzling questions.

Did *P. longicaudus* acquire its long tail and then take to the trees? Or did it take to the trees and then gradually

acquire its long tail? If it got its long tail while still living on the ground, taking to the trees when the tail reached approximately its present length, why has not *P. albipes*, which has a tail nearly as long, also adopted an arboreal habitat? If *Phenacomys longicaudus* took to tree life while still short-tailed, acquiring its long appendage thereafter through some form of environmental or other pressure associated with arboreal life, how is the acquisition of a long tail by the wholly ground-living *P. albipes* to be explained?

But in this connection it ought to be remembered that, in view of the small number of specimens of the latter species which have been taken, and of our ignorance concerning its life history, we are hardly in a position to state positively just where its habitat does lie.

Perhaps the ancestor of both *longicaudus* and *albipes* was long-tailed and is extinct and unknown. In this case possibly *longicaudus* merely selected the arboreal habitat for which its characters already fitted it. There remains the problem of why the similar *albipes*, which is to all appearances equally well fitted for tree life, did not also become a tree mouse.

If *longicaudus* and *albipes* represent successive waves of migration, perhaps *longicaudus* may be conceived to have attained to the arboreal environment before the development of *albipes*. If this were so the prior occupancy of the tree habitat by *longicaudus* would possibly be sufficient to account for the terrestrial predilections of *albipes*.

It should here be noted that if the hypothesis is true, that *Phenacomys longicaudus* is derived from some ground-living microtine, we have presented in the phylogeny of the tree mouse an unusual type of migration. The writer has already emphasized (The status of the beavers of western North America, Univ. Calif. Publ. Zool., vol. 12, in press) that in general each group of mammals occupies the same ecologic niche in different places rather than different ecologic niches in the same place. The *Microtinae* are characteristically terrestrial, with some members adapted to a more or less aquatic, and others to a more or less fossorial, mode of life. Apparently the stock which we now know as *Phenacomys longicaudus*, in the course of its phylogeny, has broken away from the time-honored group niche in which all other members of its subfamily

are found, and has come to occupy a niche entirely different. It has performed not only the usual geographic migration, but also the comparatively rare ecological migration.

## F SUMMARY

1. For 22 years subsequent to its discovery the microtine rodent *Phenacomys longicaudus* True was represented in natural history museums by but three specimens. There have been recent accessions of notes and specimens which permit of substantial contributions to knowledge of its systematic and ecologic status.

2. Habits and associational relations are just as much a part of the animal as its physical characters. In the interest of adequacy and comprehensiveness, emphasis upon study in these fields should and probably will become more insistent as time goes on.

3. *Phenacomys longicaudus* is the type of *Arborimus*, a new subgenus of *Phenacomys*. The most striking characters of the type are its cinnamon reddish dorsal coloration, its long tail, and its arboreal habitat.

4. *Phenacomys albipes* Merriam is tentatively referred to the new subgenus, though it is intermediate in certain characters between *Arborimus* and *Phenacomys*, and differs from *P. longicaudus* in several important particulars.

5. The subgenus *Arborimus* is restricted to the humid coast belt of western North America, specimens having been taken in southwestern Oregon and northwestern California only.

6. All the clear evidence at hand indicates that the tree mouse is dependent on the trees in which it lives for food, drink and shelter.

7. The tree mouse has been found nesting in the Sitka spruce (*Picea sitchensis*), the grand fir or lowland fir (*Abies grandis*), and the Douglas fir (*Pseudotsuga taxifolia*).

8. Ordinarily the nests are found in groups, so that it is proper to refer to the animal as loosely colonial.

9. Our experience with *Phenacomys longicaudus* did not show it to possess any extraordinary agility, quickness, or aggressiveness.

10. The tree mouse, from all evidence, feeds principally

on the fleshy portions of the fir needles and the cortical portions of young fir shoots, leaving the resin ducts and stripped shoots to be incorporated into the nest structure.

11. It seems probable that each individual tree mouse ranges freely through the foliage of several trees in the vicinity of its home nest-tree.

12. Probably *Phenacomys* does not hibernate, though it may become less active or altogether inactive during the coldest weather.

13. The nests vary much in size and in altitude above the ground. A majority are built against or near the trunks of the trees. In some localities old gray squirrel nests have been occupied by the tree mice. All nests examined at Mendocino City were apparently of original *Phenacomys* construction. Twigs, branchlets, resin ducts of fir leaves, and net lichen (*Ramalina reticulata*) were the chief materials used. The inner nest cavity was of soft material, either the resin ducts of fir leaves or tree moss. The nests increase in size with age; whether the increment is due to gradual accumulation of material or to annual additions at some particular season is unknown. Some of the nests seem to have been deserted.

14. Young have been found in the nest in February and in July. Numbers of young actually taken were three per family in four instances, two per family in four additional instances, and one in a single case.

15. The number of females in our collections is disproportionately large. It is possible that females are actually more numerous than males, and also that our methods of capture, involving the destruction of nests, have resulted in a larger number of females being taken.

16. Apparently only one family occupies a nest.

17. There is evidence which seems to show that males live in nests separate from those of the females for at least a part of the year, the male nests being smaller and different in other respects from the family nests; but the data are as yet incomplete and inconclusive.

18. Probably *Phenacomys longicaudus* and *P. albipes* are derived from the same species, doubtless a member, past or present, of the subgenus *Phenacomys*. Several interesting questions regarding the characters of *longicaudus* and *albipes* and their relation to habits and environment await answer.

G LIST OF WORKS CONTAINING IMPORTANT  
MATERIAL RELATIVE TO THE GENUS  
*PHENACOMYS*

ALLEN, J. A.

1894. Descriptions of ten new North American mammals, and remarks on others. Bull. Amer. Mus. Nat. Hist., 6, 331-332.  
Original description of *P. truei* (= *P. orophilus*).  
1894. Recent progress in the study of North American mammals. Author's ed., extracted from Abstract Proc. Linn. Soc. New York for year ending March 27, 1894, pp. 1-29 (17 to 45 in original form).  
Notes description of genus *Phenacomys* by C. H. Merriam, and lists six forms; contains note on origin and distribution (p. 15=p. 31 original).  
1899. On mammals from the Northwest Territory collected by Mr. A. J. Stone. Bull. Amer. Mus. Nat. Hist., 12, 1-9.  
Original description of *P. constablei* (p. 4).

ANDERSON, E. M.

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Record of capture of *P. orophilus* at Schoonover Mountain (Okanagan Falls), British Columbia (p. 20).

BAILEY, V.

1915. Discovery of the tree mouse (*Phenacomys longicaudus* True). Oregon Sportsman, 3, 147-149.  
Valuable article on habits.

BANGS, O.

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Original description of *P. celatus crassus* (p. 39).

BARRETT-HAMILTON, G. E. H., and HINTON, M. A. C.

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Fossil material erroneously referred to *Phenacomys* by Nehring disposed in the genus *Mimomys* Forsyth Major (p. 473 footnote).

CARY, M.

1911. A biological survey of Colorado. U. S. Dept. Agric., Bureau Biol. Survey, N. Amer. Fauna, 33, 256 pp., 12 pls., 39 figs. in text.  
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ELLIOT, D. G.

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Original description of *P. olympicus*.  
1899b. Catalogue of mammals from the Olympic Mountains. Washington, with descriptions of new species. Field Columb. Mus., Zool. Ser., 1, 239-276, pls. XLI-LXI, unnumb. figs. in text.  
Habitat, characters, and abundance of *P. olympicus* (p. 255).

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Seven species of *Phenacomys* listed from North America (pp. 167-169).
1905. A check-list of mammals of the North American continent, the West Indies and the neighboring seas. Field Columb. Mus., Zool. Ser., 6, v + 761, frontispiece.  
Recognizes ten forms of *Phenacomys* (pp. 226-228).
1907. A catalogue of the collection of mammals in the Field Columbian Museum. Field Columb. Mus., Zool. Ser., 8, viii + 694, 92 figs. in text.  
Specimens of the following are in Museum: *P. orophilus*, *P. olympicus* (p. 282).
- FLOWER, W. H., and LYDEKKER, R.
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Two-line general reference to the genus *Phenacomys* (p. 466).
- GRINNELL, J.
1913. A distributional list of the mammals of California. Proc. Calif. Acad. Sci., Ser. 4, 3, 265-390, pls. 15, 16.  
Lists three forms of *Phenacomys* from California (pp. 315-316).
- HOLLISTER, N.
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Treats *P. intermedius*; suggests that *P. orophilus* is identical with or only slightly differentiated from *P. intermedius* (pp. 20-21).
- JEWETT, S. G.
1915. Discovery of a rare rodent. Oregon Sportsman, 3, 37-38.  
Record of capture of second known specimen of *P. albipes* on McKenzie River, Lane County, Oregon.
- LYDEKKER, R.
1896. A geographical history of mammals. (Cambridge, University Press) xxi + 400, map, 82 figs. in text.  
Three-line general reference to genus *Phenacomys* (p. 342).
- LYON, M. W., JR., and OSCOOD, W. H.
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Types of six described species of *Phenacomys* are in the government collections (pp. 96, 97).
- MERRIAM, C. H.
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Original description of *P. preblei*.
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*P. orophilus* recorded from Squaw Creek, Mount Shasta (p. 95).
1901. Two new rodents from northwestern California. Proc. Biol. Soc. Wash., 14, 125-126.  
Original description of *P. albipes*.
- MILLER, G. S., JR.
1896. Genera and subgenera of voles and lemmings. U. S. Dept. Agric., Div. Ornith. and Mamm., N. Amer. Fauna, 12, 1-84, pls. 3, 40 figs. in text.  
Genus *Phenacomys* (pp. 40-42).
- 1897a. Synopsis of the voles of the genus *Phenacomys*. Proc. Biol. Soc. Wash., 11, 77-87.  
General statement, characterization of genus, key to species, accounts of status, characters and distribution of six forms of *Phenacomys*. *P. truei* and *P. oromontis* are referred to *P. orophilus*. *P. celatus* is referred to *P. ungava*. A bibliography of the genus, containing fourteen titles, is appended.
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Records capture of seven specimens of *P. latimanus* at Peninsula Harbor, Lake Superior; discusses characteristics and habits (pp. 8, 19-22).
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Notes two species of *Phenacomys* added to the list since their contribution in 1901 (p. 90).

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Reference to *Phenacomys* (p. 531).

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Original description of *P. mackenzii*.

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Original description of *P. oramontis* (= *P. orophilus*).

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1909. The life histories of northern animals, an account of the mammals of Manitoba (New York City, Charles Scribner's Sons), 1, xxx + 673, 46 pls., 38 maps, 182 figs. in text.

General reference to the genus *Phenacomys*, with fragmentary diagnosis (p. 516).

## STEPHENS, F.

1906. California mammals. (San Diego, West Coast Publishing Co.), 351 pp., frontispiece, many unnumbered figs. in text.

Lists two species of *Phenacomys* from California (p. 123).

## STONE, W.

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Record of finding specimen of *P. longicaudus* dead in road near "Lierlie's" Ranch, June 30, 1899 (p. 578).

## TAYLOR, W. P.

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## TROUESSART, E. L.

1897. Catalogus mammalium tam viventium quam fossilium. (Berlin, R. Friedländer und Sohn), fasc. III, 453-664.

Lists six species of *Phenacomys* (pp. 547-548).

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Original description of *P. longicaudus*.

## WARREN, E. R.

1912. Notes on the distribution of some Colorado mammals. Proc. Biol. Soc. Wash., 25, 1912, 3-8.

Additional record of *P. orophilus* in Colorado (p. 4).





DORSAL VIEW OF CRANIA OF *PHENACOMYS*.

No. 1, *Phenacomys* (*Phenacomys*) *intermedius*; No. 2, *Phenacomys* (*Phenacomys*) *orophilus*; No. 3, *Phenacomys* (*Arborimus*) *albipes*; No. 4, *Phenacomys* (*Arborimus*) *longicaudus*. About twice natural size.

Note the narrower interorbital constriction in *Arborimus*; the length and narrowness of the cranium of *albipes*, as well as the length of its brain case; and the general similarity in cranial outline obtaining between the two subgenera, shown particularly well in the comparison of *longicaudus* with *intermedius* and *orophilus*.



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VI

TERTIARY DEPOSITS OF NORTHEASTERN MEXICO

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	Page
INTRODUCTION .....	165
THE AREA .....	166
PHYSIOGRAPHY .....	167
CRETACEOUS FLOOR .....	169
ESCONDIDO BEDS .....	169
PAPAGALLOS SHALE .....	170
SAN JUAN LIMESTONE .....	170
CRETACEOUS TERTIARY CONTACT .....	171
THE TERTIARIES .....	176
MIDWAY .....	176
WILCOX .....	176
CLAIBORNE .....	177
Carrizo Sands .....	177
Marine Beds .....	177
Yegua .....	177
Fayette .....	178
Frio .....	178
AREAL DISTRIBUTION OF THE TERTIARIES .....	178
MIDWAY AND WILCOX .....	178
CLAIBORNE .....	181
Carrizo .....	181
Marine .....	182
Yegua .....	183
Fayette .....	184
Frio .....	186
UPPER EOCENE .....	188
OLIGOCENE .....	189
NEOCENE .....	192
Coquina Limestone .....	192
Reynosa .....	193

December 31, 1915.



## INTRODUCTION

In connection with the examination of the artesian water conditions of Northeastern Mexico, and the search for oil deposits in the same region, a considerable amount of geological investigation has been necessary. The field work with which the writer has been directly connected was carried on principally by Prof. W. F. Cummins, assisted by Mr. J. M. Sands. Mr. W. Kennedy also spent some time on more detailed work along the Rio Grande and in making special sections. In order that the information thus obtained may be of service to other workers in this same field, the following generalized statement has been prepared from their various reports and collections and from personal knowledge of the deposits.

It must be remembered that the work has largely been of the nature of a reconnaissance and that it has been done with a total lack of topographic maps and in part even without those giving accurate geographic detail, since these were not available until after the field work was completed. It is also to be regretted that while large collections of fossils were made during the progress of the work, only a small part of these were accessible for use in preparation of the present paper.



## THE AREA

Lying to the east of that portion of the main body of the mountainous highlands or Cordilleras of Mexico known as the Sierra Madre Oriental, which, beginning at the Sierra Carmen on the Rio Grande border, extends southeastwardly by way of Monterey and Tamasopa, there is a broad valley, interrupted in many parts by hills. This valley in turn is bordered on the east by disconnected ranges and groups of hills, which, as a whole, are roughly parallel to the main range and to the course of the Rio Grande. Among these groups and ranges may be named the San Antonio, San Juan, Vallecillo, Picachos, Papagallos, San Carlos and Tamaulipas. Prof. Cummins has proposed that these be known collectively as the Tamaulipas Range, which is seemingly warranted by the common origin of the groups.

This range consists of deposits of shales and limestones of late Cretaceous age, more or less altered and disturbed by igneous activity and by folding, and as the trend of the coast in this region is a little west of south, the southeast course of the Tamaulipas Range brings it rapidly nearer the Gulf until, in the region around Tordo Bay, fifty miles north of Tampico, the hills of this range are within ten miles of the coast and scattered peaks and ridges of later eruptives occur within four miles or less of the Gulf shore.

In the triangle thus formed by the Rio Grande, the Tamaulipas Range and the coast line we find the occurrence of Tertiary deposits which are the direct continuation of those of the Texas area, but the Tertiary beds, which, along the Rio Grande, form the surface rocks for a distance of 150 miles, narrow rapidly toward the south, the lower beds disappearing in turn by reason of successive overlaps of the later, until, at the southern end, on the Zarzizal River, just north of Tordo Bay, the entire exposure shows no Tertiary beds below the Oligocene, which has here a width of a very few miles.

The Tamaulipas Range thus marks the extreme western and southern limits of these beds and, so far as our investigations go, this area contains the last appearance in Mexico of the Eocene beds as known in Texas, since the beds of this age which are found south of the Tamaulipas Range have a fauna more nearly related to those of the deposits of the Pacific Coast.

## PHYSIOGRAPHY

The structure of this coastal area is largely that of a monoclinal plain with local foldings which are, however, of very slight extent, except in close proximity to the western boundary. Within it there are comparatively few exposures of igneous rocks and these are confined to its southern portion, and, as a whole, it corresponds closely in its topographic features with the southwestern Texas region. The gentle slope of the land immediately adjacent to the Gulf shore, which has such a broad development in the Texas coast prairies, here rapidly narrows toward the south. In the more elevated region directly west of it are exposed the calcareous materials and conglomerates which were first described from Reynosa on the Rio Grande and named for that place. These beds, which may be correlated with the Lafayette formation of the Pliocene, not only form the surface rocks of the area lying east of that in which the lower Tertiaries are now exposed, but judging from the numerous residuals occurring over the entire area and even in the Tamaulipas Range itself, seem, when originally laid down, to have formed a mantle over it all. Indeed, this formation, either by its actual presence or by the wide distribution of the detritus from it in the territory from which it has been denuded, masks and covers the underlying beds to such an extent as to render it difficult, if not impossible at many places, to determine their age or even their character.

Taken as a whole, the area occupied by the lower Tertiaries is one of rather low relief as compared with the territory west of it and hills of any considerable height above the general level of the country are rather few and principally confined to the western portion. They are practically all the result of erosive action. In the northwestern portion of the area there are long ranges of these hills extending from Amole Creek to the Salado River which are known as the Ceja del Macha and Ceja Madre and are made up of clays and hard Tertiary sandstones. To the south similar but lesser ranges and isolated hills occur which owe their existence to other sandstones and clays of the same or later horizons. To this class also belong the hills east of Cerralvo, the Sierra Colorado northeast of Ramones, Loma Alta and

Sierra Larga in the valley of the Salinas River near Her-  
reras, and other similar hills along the western margin of  
the area as far south as the Conchos River.

The Sierra de Pomeranes, east of Mendez on the Con-  
chos, while composed principally of sediments of middle or  
upper Eocene age and largely due to erosive action, seem  
to be connected also with the Corcovado uplift and mark  
the beginning of the influence of such orogenic movements.  
These become more and more manifest toward the south  
as shown in the Martines hills east of Abasolo' and in the  
San Jose de las Rusias hills, where igneous rocks make  
their appearance breaking through the sediments of the  
upper Oligocene. The northern half of the area is drained  
by affluents of the Rio Grande. The most northerly streams  
of interest are the arroyos de Caballero and del Amole, a  
few miles south of Guerro. Following these the Salado  
River, which drains the Sabinas and Esperanza coal fields,  
crosses this belt and empties into the Rio Grande opposite  
Zapata. The principal branch of this river on the south is  
the Sabinas. South of these, the Salinas River (also called  
the Pesqueria) coming in from the region just north of  
Monterey, joins the San Juan near Aldamos. The San  
Juan itself, which drains the area south of Monterey, flows  
northeastward and reaches the Rio Grande at Carmargo.  
South of the Rio Grande the only two important river sys-  
tems are the Conchos and the Soto la Marina. The Conchos  
heads west of Linares and, flowing north of the San Carlos  
and Burgos groups of mountains, reaches the gulf by way  
of Mendez and San Fernando, while the Soto la Marina,  
rising just southward of Linares, flows southeastward by  
way of Abasola and Soto la Marina, passes between the  
Sierras de Martines and Tamaulipas and then turns east-  
ward to the gulf. In its lower reaches the Conchos River  
is sometimes called the Presas. Between these two rivers  
is the arroyo Chorreras and south of them the Zarzizal,  
which empties into Tordo Bay.

## CRETACEOUS FLOOR

The deposits of Cretaceous age which appear in this area in connection with the Tertiary are: The Escondido Beds, the Papagallos Shales and the San Juan Limestones.

## ESCONDIDO BEDS

These beds as described from the Rio Grande section<sup>1</sup> comprise the materials lying between the top of the Coal Series (that division of the Taylor marls which contains the coal deposits of Eagle Pass, Fuente, Sabinas, Esperanza, etc.), and the basal Tertiary and consist of alterations of clays and sands, more or less glauconitic, with an abundant and characteristic fauna, which is as yet only partially described. *Sphenodiscus pleurisepta* Con., and *Ostrea cortex* Con., are probably the most abundant species in it, although it also carries a large gasteropod fauna, including *Buccinopsis parryi* Con., *Volutomorpha texana* Con.

On the Rio Grande the rocks of this formation extend from Eagle Pass to the mouth of Caballero Creek, where we found its contact with the Midway, or basal Eocene. This contact was traced southward as far as the Rancho del Pescado, a few miles southwest of the Laguna de la Leche, where we found the last exposure of the clays with *Ostrea cortex*. It is probable that the brown clays and shales occurring on the Salado River and tributaries north of Rodriguez, may belong to the Escondido, but we found no fossils that would enable us to place them there with certainty, nor were we able to recognize them farther south.

The Escondido is the latest Cretaceous known in the Texas area. In its lower part it carries *Exogyra costata*, but this is absent from its upper beds. Stephenson says of it:<sup>2</sup>

"In this connection it should be stated that the Rancocas and Manasquan formations of New Jersey, which carry only a meager fauna, are thought to be somewhat younger than the *Exogyra costata* zone, and the upper part of the Escondido formation of southwestern Texas may be a little younger

<sup>1</sup> Dumble, E. T., Notes of the Geology of the Valley of the Middle Rio Grande, Bull. Geol. Soc. of A., Vol. 3, p. 227, 1892.

<sup>2</sup> Stephenson, L. W., "Cretaceous-Eocene Contact," U. S. G. S. Prof. Paper 90-J, p. 157, 1915.

than that zone, although its fauna is composed of strictly Mesozoic types, of which the genus *Sphenodiscus* is the most striking example."

#### PAPAGALLOS SHALE

To the west of the final exposure of the Escondido beds near the Pescado Ranch and apparently dipping under them, there is a series of very fine-grained blue or black limy clay shales, weathering brown, yellow or white, in which we have so far found no fossils. These shales carry both selenite and barite and weather into slaty particles. These shales were first studied by us in the Papagallos Hills west of Ramones and we have given them this name. The Papagallos shales are exposed along the western border of this area from the San Antonio Range, on the north, nearly to Tordo Bay and are also found over extensive areas south and west of the Tamaulipas Range. They overlies the gray limestone of the San Juan and have a very considerable thickness.

#### SAN JUAN LIMESTONE

Exposures in various canyons of the Tamaulipas Range show, underlying the Papagallos shales, a series of thin to medium bedded gray limestones with *Inocerami* and *Ammonites*. The fossils so far found are not very well preserved, but the *Ammonites* seem to fix the age as equivalent to the Taylor or Austin beds of the Texas Cretaceous. In a few places the Tertiary beds overlap the Papagallos and rest directly upon these limestones.

South and west of the Tamaulipas Range the Papagallos shales and San Juan limestones occupy a very large area, overlies the Tamasopa limestone, which is the top of the Middle Cretaceous, and represent the entire series of Upper Cretaceous beds of the Mexican geologists as known here.

The exact correlation of these beds with those of the Texas section is not yet possible, as they represent an entirely different phase of deposition and carry so few fossils.

The upper Tamasopa limestone around Micos is correlated by Bose<sup>3</sup> with the Woodbine or Timber Creek beds of the Upper Cretaceous of Texas, which is probably of the same age as the Dakota of the interior region.

<sup>3</sup> Bose, E., "Neue Beitrage zur Kenntniss der Mex. Kreide," p. 10, 1910.

Around Cardenas, which is on the table-land east of San Luis Potosi, overlying the Tamasopa limestones there are highly fossiliferous beds which apparently represent the Eagle Ford, Austin and part of the Taylor, as these formations exist along the Rio Grande southeast of Del Rio.

In the Coastal plain of Mexico, east of the Cordillera, the place of these fossiliferous beds is occupied, as has been stated, by the San Juan and the non-fossiliferous Papagallos, and these two formations stretch northward to the Salado River beyond which we find again the fossiliferous beds of the Upper Cretaceous. They, therefore, in all probability either represent the deeper sea deposition of which the fossiliferous beds were more nearly littoral or indicate the existence of a barrier of some description in this vicinity during the later period of the Upper Cretaceous. The evidence seems to favor the latter condition and that at the close of the Cretaceous this barrier was extended to the southeast by an uplift or uplifts which formed the series of mountain groups and ranges here referred to as the Tamaulipas Range.

On the Rio Grande there appears to be only a slight angular unconformity between the Cretaceous and the Tertiary, but, going southward, we observe that the disturbances at the close of the Cretaceous folded and flexed the limestones and shales so that the contacts from Rodriguez south show very decided unconformities.

### CRETACEOUS-TERTIARY CONTACT

The contact between the Cretaceous and the Eocene which, beginning south of San Antonio, Texas, runs a little south of west to the southwestern portion of Uvalde County, makes an abrupt turn at that point and then runs almost due south for more than 250 miles to the Salinas River. From this point it turns southeastward to the Conchos which flows for miles along the southern boundary of the Eocene deposits. The contact between the Cretaceous and the Eocene in Mexico was first found on the Arroyo Caballero, a small creek which empties into the Rio Grande on the Mexican side some three or four miles north of the Maverick-Webb County Line in Texas. From this point the contact runs southwest

to the hills north of Azulejo, where it turns and runs a little east of south, crossing the Salado River near Rodriguez, the Sabinas near Piedras Pintas and the Salinas at Ramones. It was not traced between the Salinas and the Conchos rivers, but it was found on the latter stream near Panalito and traced in a general way southeastward to the Zarzizal. Actual contacts were found in a number of places and the relations determined in others by such proximity of the deposits of the two formations as renders the line here given a fair approximation of the existing conditions.

The upper beds of the Escondido formation are well exposed on the Rio Grande between Las Isletas and the Arroyo Caballero. They consist chiefly of greenish blue shales with calcareous bands overlain by brownish ferruginous sandy clays and sands. The calcareous bands of the lower division carry *Volutomorpha texana* Con., *Buccinopsis parryi* Con., and other gasteropods in large numbers. The overlying sands carry *Sphenodiscus pleurisepta* Con., and large *Turritella*. The following section was made a few yards above the mouth of the Arroyo Caballero:

	Feet.
Alluvial material .....	4 to 6
Tertiary:	
Yellowish clay .....	6 to 8
Hard bluish gray sandstone with <i>Ostrea</i> <i>pulaskensis</i> , <i>Turritella</i> , etc. ....	6
Cretaceous:	
Bluish sand with <i>Sphenodiscus pleuri-</i> <i>septa</i> .....	6
Black hard sandstone.....	2
Laminated blue clay.....	6

Other exposures showing similar contacts were seen in the vicinity.<sup>4</sup> No evidence was observed of erosion of the Escondido beds before deposition of the Midway, but the beds of the two formations dip at different angles and to the southward the Midway is found in contact with what are seemingly lower horizons of the Escondido and with the

<sup>4</sup> Note—For details of similar contacts on the Texas side, along the river bluffs and in the uplands, see Stephenson, L. W., "The Cretaceous-Tertiary Contact," U. S. G. S. Prof. Paper 90-J, 1915.

Papagallos shales which are supposed to underlie the Escondido, thus indicating an unconformable overlap.

Amole Creek flows in a long narrow valley in which the Amole Ranch is located. After crossing the creek west of Perros Bravos the country for several miles to the west is covered with the Reynosa, but after passing this, the road crosses a series of small benches made up of thinly bedded yellowish sandstones weathering brown and carrying fragments of oysters. Just west of Amole we found a contact between shaly brown sandstone with abundant *Ostrea cortex* Con. and a somewhat similar sand with *Ostrea pulaskensis* Har. This later sand is overlain in the neighborhood of the Cuevas Ranch by grayish yellow sandy clay and this in turn by the Carrizo sand, which to the south becomes the most prominent member of the Tertiary, overlapping in many places both the Lignitic and Midway to a contact with the Cretaceous. The Cretaceous (Escondido) sandstones noted west of Amole also appear along the western side of the Ceja del Macha and as far south as the Pescado Ranch, underlying a dark brown clay carrying boulders and containing broken and worn fragments of *Ostrea cortex*, which we refer to the Midway. South of the Pescado Ranch we find a large area covered by the deposits of the Reynosa and an old lake bottom, beyond which the first recognizable Cretaceous was encountered in the San Antonio hills. These hills on the eastern side of the Salado River appear to be made up principally of the yellow clays of the Escondido with a plating of gravel.

The Salado River flows in a narrow valley, lying between the San Antonio and San Juan hills, and the sections made here gave us the relations of the various members of the Cretaceous, which are found in contact with the Tertiary. On the west side of the Salado, the San Juan Hills are made up of a series of thin to heavy bedded limestones interstratified with thin beds of yellowish clay. This is the type locality of the San Juan beds. Towards the base the limestones are shaly, dark gray in color, and weather gray to whitish. Toward the summit the limestones are of a bluish shade, weathering white. The uppermost beds are sandy and weather to a reddish or rusty brown color. They



carry numerous impressions of ammonites, oysters, and inocerami, which are of forms referable to the Taylor or Austin horizons of the Texas section. These beds underlie the shales of the eastern side of the river. The greater portion of the Salado Valley is filled with a heavy bed of conglomerate, but from near Santa Rita southeastward to Reparo Creek near Rodriguez, a distance of over 25 miles, there are numerous exposures of heavy beds of greenish-yellow sandy clay, which may be the base of the Escondido, overlying a series of blue clays, blue shales and black shales, with indurated bands. These latter clays are laminated and massive, carry more or less selenite, some calcite and barite, and in places boulders of a yellowish brown hard flinty sandstone. No fossils were found in them, but they are the direct stratigraphic continuation of the beds we have called Papagallos. These rest upon the San Juan beds.

The Escondido with *Ostrea cortex* appears on Camaron Creek about midway between the San Antonio Hills and Ceja Madre and in the western slope of the Ceja Madre we find the brown and blue shaly clay and marls of the Midway with *Venericardia alticostata*, etc.

Reparo Creek joins the Salado River just west of Rodriguez. Half a mile above the junction of the streams, we have a section showing a contact in which the yellowish brown shaly clay of the Wilcox rests on the blue Papagallos shales of the Cretaceous, while further up the creek we find the fine-grained brown and gray sandstones of the Carrizo in contact with the Cretaceous shales at several places. This indicates the transgression of both the Wilcox and the Carrizo over the Midway in this locality. From Rodriguez the outcrop of the blue shale continues down the west side of the Salado River to within a few miles of San Jose and then turns southward, crossing the Sabinas west of Piedras Pintas. At Vallecillo we have the San Juan limestones with Inocerami followed to the east by the Papagallos shale and this by the Midway (?) at Piedras Pintas. From here the line of contact runs south to a point three miles east of Cerralvo where there is a range of hills with eastward facing scarp and northeast dip. They have a height of 200 feet and are made up of the blue and yellow shales of the Papagallos which show

in them, here and there, massive blue nodules or boulders which weather white. To the east of these hills lies a valley two miles wide, and the hills which form its eastern margin are composed of the sands and clays of the Midway.

The Papagallos Mountains lying west of Ramones rise somewhat abruptly from the river and at the distance of a mile attain an elevation of 800 feet. So far as can be seen, the range is made up of highly metamorphosed blue shales, which weather white on exposure and which have been folded into a sharp anticlinal, the dip of which on its eastern slope is as much as 60 degrees, while the dips on the west vary from 30 to 70. The entire valley to the west seems underlain by the same shales but with greatly lessened dips, and these form small hills at Ayancual and elsewhere. These shales also stretch to the east and exposures on the river show that they were considerably disturbed and crumpled prior to the deposition of the Eocene beds. These beds were not traced between the Pesqueria and the Conchos, the line of travel lying east of them and over the Tertiary deposits.

On the Conchos River the conditions appear to be similar to those on the Salinas and the only exposures of the Papagallos shales seen were in the river below the Tertiary beds. The main body of the Cretaceous deposits lies west of Vaqueria. They then swing eastward around Burgos Peak, southeast of which the San Juan limestone is found in a canyon. From this locality several poor specimens of ammonites, including a *Mortoniceras* (?), sp. were collected, of which Dr. T. W. Stanton says: "The genus *Mortoniceras* occurs in the San Carlos beds, in the Austin chalk, and in the Tombigbee sand. If correctly identified, the presence of this genus probably means the limestone is not younger than the Taylor marl and may not be younger than the Austin chalk." To the southeast of this on the road to Cruillas the blue shales come in again. Northwest of Abasolo the San Juan limestones appear, while Abasolo itself is on the blue Papagallos shales and these extend southward along the river as far as Soto la Marina, at which place they are also found in wells. In this region they are overlain in places by the yellow clays of the San Fernando and by the Coquina limestone and the Reynosa.

Between Soto la Marina and San Rafael the only contacts observed were between the San Fernando and the eruptives lying east of the Tamaulipas Range.

## THE TERTIARIES

Our examination of the deposits occurring along the Rio Grande and overlying the Escondido failed to show any beds of the Eocene of later age than the Frio substage of the Claiborne. This was followed directly by our Oakville or upper Miocene. No Oligocene or lower Miocene are present there, so far as our present knowledge serves.

The formations recognized are: <sup>5, 6, 7, 8</sup>

	{	Frio
		Fayette
Claiborne:		Yegua
		Marine
		Carrizo
Wilcox,		
Midway.		

Between the Rio Grande and the Conchos, however, we find the Oligocene coming in between the Frio and overlying materials and to the south it attains a strong development.

Briefly stated, the characteristics of the several divisions of the Eocene as known on the Rio Grande are as follows:

### MIDWAY

Gray clays with limestone concretions overlain by bluish shales and shaly sandstone interstratified with ferruginous sandstone, both series carrying *Venericardia alticostata*, *V. planicosta*, *Ostrea pulaskensis*, *Cucullæa macrodonta* and other forms.

### WILCOX

A lower series consisting of blue and gray sandy shales, light gray sandstones and bluish, carbonaceous, sandy shale

<sup>5</sup> Dumble, E. T., "The Cenozoic Deposits of Texas," Jour. Geology.

<sup>6</sup> Vaughan, T. W., Reconnaissance of the Rio Grande Coal Fields of Texas, U. S. G. S., Bull. 164, 1900.

<sup>7</sup> Dumble, E. T., "Geology of Southwestern Texas," Trans. Am. Inst. Min. Eng., 1902.

<sup>8</sup> Dumble, E. T., The Carrizo Sands, Trans. Tex. Acad. Sci., 1911.

with sulphur which is overlain by a second series, comprising black, lignitic, sandy shales with concretions or boulders of gray carbonate of iron, weathering red, lignitic deposits, etc. Fragments of *Cardita*, etc.

#### CLAIBORNE

The Claiborne, as a whole, comprises several alternations of deposits of clays and sands, and for purposes of description and mapping, is divided into substages.

##### *Carrizo Sands*

Sandstones of varying color, texture and thickness. The prevailing color is a grayish yellow, weathering light brown. Some of the beds are white when freshly broken. In texture they range from fairly hard sandstone, lying in beds of two to four feet or more in thickness, to thin slabby, fairly soft, and almost shaly structure. No fossils except a few plant remains have been found in them.

##### *Marine Beds*

Greenish clays and lignitic sands with palmetto and other plant remains, and some lignite, overlain by carbonaceous clays and sands with gypsum and particles of lignite, capped by brown or buff sandstone. These beds are not so glauconitic on the Rio Grande as they are in eastern Texas. This substage usually carries an abundant and characteristic fauna, including such forms as *Venericardia planicosta* Lam., *Anomia ephippioides* Gabb, *Ostrea divaricata*, *Nassa texana* Gabb, *Distortix septemdentata* Gabb.

##### *Yegua*

At the base, interbedded brown sands, chocolate clays with green sand, and lenticular masses of red sandstone; then buff and greenish sands slightly calcareous with occasional bands of limestones, gypsum and cannon-ball concretions abundant. Buff sandstone overlain by blue and green ferruginous clays with calcareous concretions followed by yellow sandy clay form the upper portion of the measures. In places the concretions in these beds carry aragonite and chalcedony. While not fossiliferous throughout, the beds carry a typical Claiborne fauna and are characterized by *Tellina mooreana* Gabb, var., *Turritella houstonia* Har., *Natica recurva* Aldrich.

*Fayette*

Buff sandstone with greenish, sandy clay, lignitic clays with concretions and some lignite, opalized wood and chalcedony. Fossils are abundant in these beds along the Rio Grande; the most characteristic being *Ostrea alabamiensis contracta*, *Cornulina armigera heilpriniana* Har., *Cerithium pliciferum* Heilp.

*Frio*

Gypseous clays with sands. Clays gray and green in color, often weathering white and containing leaf impressions and ferruginous and calcareous concretions. The fossils, which are not numerous, are oysters of smaller size than those of the Fayette, *Corbula*, etc.

## AREAL DISTRIBUTION OF THE TERTIARIES

## MIDWAY AND WILCOX

While there are numerous localities at which it is possible to distinguish the various stages of the Eocene, by their several lithologic and faunal characteristics, it will require more detailed work to show the exact areal distribution of the lower members. This is due to general similarity of materials, scarcity of distinguishing fossils at many places, the successive overlapping of the upper members upon the lower, and the widespread occurrence of the Reynosa, which covers them over many square miles. This applies especially to the Midway and Wilcox, and to the Carrizo Sands of the Clai-borne. For this article, therefore, the area occupied by the deposits of these stages will be treated as a unit, noting the various occurrences of each where identified, but leaving the area as a whole undifferentiated. The area has for its western boundary, along which we may find any or all of these deposits, the Cretaceous-Tertiary contact just described. Its eastern border, which is the line of contact of the Marine substage with the Carrizo Sands, crosses the Rio Grande just south of the mouth of Espado Creek and, running south-eastward by Hidalgo, crosses the International Railroad near Jarita, 16 miles west of Laredo, and the Salado at Los Moros, 10 miles west of Guerrero. It then takes a southerly

course to its crossing of the railroad and Pesqueria River, a short distance west of Herreras, and then southeastward again to near Vaqueria on the Conchos, which is near its southernmost exposure.

Along the Rio Grande the Midway with its fossiliferous beds is fairly persistent for some distance and forms the base of the hills to a point a mile or more south of the mouth of Penitas Creek. But it is not often the surface rock, as it is usually covered by the Wilcox or Carrizo.

The Wilcox appears only in limited areas, having probably been subjected to erosion before the deposition of the Carrizo and while it occasionally appears on this river between the Midway and Carrizo, there are many exposures in which it is lacking and the Carrizo rests directly upon the Midway. This is well shown in the Cerrita Prieta and the hills to the south.

South of the river the brown, fossiliferous sandstone of the Midway is well exposed for several miles and it is seen again at a crossing of Amole Creek nine miles southwest of Perros Bravos.

On Amole Creek the Wilcox appears below the Carrizo in places, while at others the Carrizo Sands rest directly upon the Midway or even on the Escondido beds.

West of Amole Creek the Midway sandstone is underlain by shaly sandstones with small oysters, and these are underlain by the Escondido beds with *Ostrea cortex*. Along the western side of the Ceja del Pescado, a low range of hills, lying south of Azulejo, there appears a series of shales and sandstones weathering to a dark brown, clayey soil carrying the distinctive boulders of the Midway, and broken fragments of *Ostrea cortex* as found at base of the Midway elsewhere. This range of hills stretches southward for some miles.

The Carrizo, as has been stated, has a very wide extension in the northern part of the area and forms the top and eastern slope of the various small groups and ranges of hills north of the Arroyo Agua Verde and of the longer range known as the Ceja del Macha and Ceja Madre, which extends from Azulejo nearly to the Salado River.

South of the Salado, the conditions seem to be different

from those in the territory nearer the Rio Grande. The Carrizo is less dominant, in fact between the Salado and the Pesqueria and along the railroad we observed no beds certainly referable to the Carrizo, although it doubtless occurs. While the exposures of the Wilcox are still limited, the Midway shows much greater development.

On the road from Mier to Cerralvo, we find  $2\frac{1}{2}$  miles west of La Masa, a range of hills trending northwest and southeast and having a northeast dip. The section shows:

	Feet.
Sandstone .....	8
Yellowish clay .....	10
Fine-grained, smooth, yellow sandstone.....	10
Blue clays weathering yellow.....	20
Alternating clays and sandstones in thin beds.	

The character of these beds and their stratigraphic position warrant their reference to the Midway. They occur again at a creek crossing 10 miles south of Cerralvo on the Herreras road and a hill in this vicinity is capped with fossiliferous sandstone showing Midway forms. They also have a wide development in the valley of the Pesqueria River between Ramones and Herreras.

A hill north of La Masa gives us a section of the Wilcox clays overlain by the Carrizo, and similar beds were observed southeast of Cerralvo.

The town of Ramones is located on the blue shale of the Papagallos and exposures are seen in the river bed for two or three miles east of the town, underlying the yellow clays of the Midway and the calcareous conglomerate of the Reynosa.

A quarry  $2\frac{1}{2}$  miles north of Ramones gives the following section:

	Feet.
Thin soil .....	1
Thin bed of ferruginous sandstone containing <i>Venericardia alticostata</i> , <i>Ostrea pulaskensis</i> , etc. ....	1 to $1\frac{1}{2}$
Thinly laminated shale, gray and black.....	4 to 12
Soft gray sandstone.....	10

Another quarry to the south of this, on the ridge dividing the river and Ayancual Creek, shows the same limestone with the same fossils and they are seen again at the head of an old irrigation ditch near Hacienda Nueva, five miles west of Herreras. North of the river the Midway includes a series of interstratified blue and brown, shaly clay and gray, brown or white sandstones which extend for several miles and find in the Alto Colorado their most conspicuous development. This hill is three miles north of kilometer 1121 on the railroad. It shows the following section:

	Feet.
Brownish gray, heavy bedded sandstone.....	3
Limestone, fossiliferous .....	1
Brownish sandstone .....	8
Blue clay, weathering yellow.....	3
Yellow brown sandstone, somewhat calcareous, fossiliferous .....	160
Yellow, shaly clay .....	80

The fossils are not very well preserved, but include *Ostrea pulaskensis*, *O. crenulimarginata*, *Venericardia planicosta*, *V. alticostata*, *Turritella*, and other undetermined gasteropods. The same beds were also observed 16 miles southeast of Ramones on the road to China, which was the most southerly exposure of them which we could identify.

A mile southeast of Comit s, on the road from Ramones to China, there is an exposure of typical Wilcox strata but without any fossils. It consists of heavy beds of clay with nodules of clay ironstone, weathering red.

#### CLAIBORNE

##### *Carrizo*

South of the Pesqueria, sandstones, probably referable to Carrizo, were seen 2½ miles west of San Juan and there was also seen a gray sandstone with westerly dip a few miles north of Vaqueria, which may represent it. The greatest development of these sands, however, both in Texas and Mexico, is found in the drainage area of the Rio Grande.



*Marine*

The beds belonging to the Marine substage of the Claiborne, as seen on the Rio Grande, have a wide development, the river flowing through them from the mouth of Espado Creek to a point eight miles south of Laredo, a total distance of 50 miles, but this is at an angle to the dip of the beds. They narrow rapidly to the south and where they cross the Salado River west of Guerrero, their outcrop is not more than five or six miles wide. East of Cerralvo, they occupy the area between La Masa and the General Trevino Ranch.

Like the Midway, the Marine beds are well developed in the valley of the Salinas. Indeed, the valley of the San Juan, of which the Salinas is a part, gives by far the most complete and satisfactory section of the Atlantic coast type of Eocene deposits which we have so far found in Mexico. Two miles north of Herreras, there is a hill 170 feet in height, known as Loma Larga, with an escarpment facing west and south, the beds of which have a southeast dip. The section is:

	Feet.
Reynosa limestone .....	4
White clay with small concretions.....	6
Yellow clay with interbedded micaceous sandstone .....	30
Greenish sandy clay.....	10
Blue shale and clay with septaria.....	120

The fossils identified from this locality include *Venericardia planicosta* *V. potopacoensis*<sup>6</sup> and others. An exposure on the railroad half a mile east of Herreras shows similar beds with numerous fossils belonging to the Marine stage. This section was repeated in an exposure on the river south of the railroad. A mile east of Herreras, a long shallow cutting on the railroad shows a section of grayish yellow clay and thin calcareous sandstone. Here were found quantities of well preserved fossils, consisting principally of *Venericardia planicosta* and *V. potopacoensis*. The position and dip of these beds would place them at the base of, or below, the

<sup>6</sup> This form is well known in the Maryland Tertiaries but has not been found previously in the Gulf Tertiaries.

beds exposed in the Loma Larga. East of this cutting we found gray sandstones and shales and brown, ferruginous sandstones which extend east within a mile of La Laja. Among the fossils found in them were *Ostrea alabamiensis*, *O. sellæformis*, *Venericardia planicosta*, *Pyrula*, sp. (?), *Cassidaria*, sp. (?) and many smaller forms. Continuing south of the Pesqueria, there is found three miles southeast of Comitas a succession of low ridges caused by the upturned edges of sandstones of this age with an abundant fauna, which, however, is very firmly embedded in the calcareous sands. On the San Juan River west of China and between Barranca and San Juan, the Marine beds of clays and sands with *Ostrea alabamiensis* are found. The road from San Juan to Vaqueria shows many exposures of these beds. A hill half a mile west of La Ciga gives, at its base, a good section of the clays and sands with *Venericardia potopacoensis* and other forms. At Jaboncillos Ranch, 20 miles south of San Juan, a calcareous band was found, composed largely of *Venericardia potopacoensis* and this stratum was followed for 10 miles in a southeasterly direction toward the Conchos. It dips N. E. 10°. While no fossils were found which positively identified them as Marine, it is probable that the yellow clays and sands along the river east of Vaqueria belong to this substage.

### *Yegua*

The beds belonging to the Yegua substage form the surface rocks on the Rio Grande from eight miles south of Laredo nearly to the mouth of the Salado River. Their eastern border in this area is found west of Guerrero on the Salado and extending southward, crossing the road from Mier to Monterey, a short distance east of the Borregas Ranch; the Brownsville-Monterey railroad, 6 miles east of La Laja; the San Juan River just west of China, and the Conchos west of Mendez. Its fossils are principally oysters and are usually poorly preserved. They are probably *Ostrea alabamiensis*. At the foot of a hill a short distance east of Borregas Ranch, there is an exposure of beds of purple sandstones and clays, one of which is composed almost entirely of the cannon-ball concretions of the Yegua. From these beds we collected the

following fossils: *Venericardia planicosta*, *Volutilithes petrosa*, *Pseudoluva vetusta*, *Natica recurva*, *Harpa*, sp., *Pecten*, sp., etc. At the top of the hill are the Fayette sands with *Ostrea contracta*. Southwest of Borregas the road passes hills of reddish and purplish sandstone and yellowish sandy clays which are also red in places. These beds have a north-east dip and are visible until the San Domingo Ranch is reached, 6 miles west of Borregas. Beyond this the country is level with no exposures for several miles until we find a hill which shows the purple sands of the Yegua underlain by the gray and yellow sandy clays of the Marine. Near La Laja, which is on the railway near the Salinas River, the Yegua occurs as heavy bedded gray, bluish gray, and red sandstone with blue, brownish yellow and red clay shales, followed by thinly stratified gray clays and sandstones. The only fossils found were fragments of oysters. Half a mile west of La Ciga, a small hill showing Marine strata at its base seems to be capped with Yegua, a few fossils, including *Natica recurva*, indicating that age. East of La Ciga the chocolate sandstones and clays with cannon-ball concretions are exposed in a low ridge for several miles. The Yegua continues to the Loma ford on the San Juan River, two or three miles west of China. On the Conchos River, one mile east of Angeles, where a large creek enters the river from the south, there is a bluff some 75 feet in height with 25 feet of purple lignitic shale at base, capped by yellow clays with shaly sandstones and beds with nodules of carbonate iron weathering red. This is typical Yegua. The latest beds of Yegua seen were east of Sonada, where there are exposures of blue and yellowish clays with gypsum, interbedded with beds of sandstone four inches to two feet in thickness. Beds of brown clays in a hill one mile west of Mendez mark the top of its development here. No fossils were found here, but its lithologic character and stratigraphic position warrant the reference.

#### *Fayette*

The Fayette, like the Carrizo, is predominantly sandy. Like the Carrizo also, the Fayette, at times, overlaps the lower substages of the Eocene. Its exposure on the Rio Grande is fully equal to that of the Marine, stretching from

just north of the junction of the Salado and Rio Grande almost to the mouth of the San Juan. On the Rio Grande it carries many fossils connecting it directly with the Claiborne, together with others distinctively its own, the most prominent of which is the large oyster; *Ostrea alabamiensis contracta* Conrad, by which we have identified it as far south as the Conchos.

The town of Mier is on the Fayette sands, which here have a northeast dip. They are well shown in places along the road from Mier to Camargo and on the river. The upper beds are a series of yellow sands and greenish yellow clays with gypsum, overlying yellow sandy clay with *Ostrea contracta*, and sandstone beds alternating with yellow clays. Going southwest from Mier we pass over the same beds, until near Borregas at the edge of a scarp facing northwest, we find the lowest Fayette with *Ostrea contracta*. This is underlain at the bottom of the hill by Yegua. About a mile north of Borregas Ranch an outlying hill shows the Fayette as yellowish sand and pinkish sands and clays with leaf impressions. The section is:

	Feet.
Yellow sandstone, <i>Ostrea contracta</i> .....	3
Yellowish and purple clay.....	20
Clayey limestone, fossiliferous.....	1
Yellow and pinkish clays.....	10
Yellow sandstone, leaf impressions.....	3

These beds dip N. E. On the Matamoras-Monterey railroad the Fayette sands begin six miles east of La Laja. The exposures show light gray, almost white, sandstone ranging from two to four feet in thickness, quartzitic in places, and interbedded with softer sands and clays. West of Los Alamos is a bluff of sandstone with oysters. The top weathers very rough. The Fayette beds have a northeast dip and extend along the railroad some five miles or more east of the river. In the bank of the San Juan River north of China, these sandstones and clays make their appearance and the road from China to Chilarios shows them as a series of gray sandstones and clays, some of the sandstones being concretionary and some thin-bedded and ripple marked. Near

Chilarios the oyster beds are found with fragments of *Ostrea contracta*. The development of the Fayette sands in the vicinity of the Conchos River is quite extensive. They form the western flank of the Sierra de Pomaranes and the continuation of these hills to the south and west of the river, overlapping the lower beds of the Tertiary to a contact with the Cretaceous (San Juan) limestones east of Burgos Peak. It is only the erosion of the river which has brought to light the few exposures of the lower beds of the Eocene, which we have described as in its basin. The upper beds of the Fayette which cross the river at and east of San Diego and the San Pedro Ranch, are composed of massive rough weathering sandstone with a few large oysters. These extend up the river valley to within a mile of Mendez, where they rest on the Yegua. They appear west of this in a hill near Piedras. As nearly as we can determine, they form the plateau north of the river. The same beds are seen forming the plateau southward toward Burgos; on a creek west of Burgos, dipping west at high angle and overlain by Equus beds; and are found again three miles east of Burgos. They also form the body of Mt. Corcovada, where they show a westerly dip. The road from Burgos to Cruillas has few exposures and these only of yellow clays, but between Cruillas and Choreras the gray sandstone of the Fayette occurs in a hill, and it is found lying in low ridges a few miles southwest of Choreras. This is the last exposure we are able to identify as Eocene in this area.

To the west the Cretaceous limestones and shales come in and continue down the Soto la Marina to Abasolo, while from Choreras southward, the San Fernando practically covers all the lower beds and rests directly upon the Cretaceous.

### *Frio*

On the Rio Grande the Frio beds are found capping the Fayette just south of Roma and disappearing under the Oakville below Rio Grande City. They form the surface rocks, where the Reynosa is absent, in the valley and to the north of the San Juan River for 30 miles or more southwest of Camargo.

South of the Salinas River on the road from China to Laguna de los Indios we find, beginning a mile west of Chilarios, a series of yellow clays with nodules of red clay, ironstone and gypsum, which apparently belong to the Frio. Southeast of Chilarios all the washes and gullies show the yellow gypseous clays with only a few shaly sandstone beds. These carry the small oyster of the Frio. Just how far these beds extend to the southeast before they are covered by the yellow sandy clays of the Oligocene, could not be determined owing to lack of suitable exposures. Similar clays were, however, observed 24 miles southeast of Chilarios. The best development of these beds was found in the region of the Conchos River. Between Tepetate and the San Francisco Ranch, northwest of San Fernando, they comprise yellow clays and soft gray sandstones, dipping northeast and carrying oysters. The hills stretching northwest from this locality are largely made up of these clays and sands with beds of gypsum and in the Sierra de Pomeranes they also show a considerable thickness and are interbedded with or carry gypsum in all its varieties. Here they are underlain by the Fayette and capped by the San Fernando. At San Diego, which is at the southern point of these hills, the Frio shows in a ridge capped with three feet of massive gypsum underlain by greenish clays weathering white and carrying the Frio oysters. Their extension south of the Conchos, if any, has not yet been worked out.

So far as our investigations show, all exposures of Lower Eocene (Midway and Wilcox) deposits are confined to the limits of the present drainage basin of the Rio Grande. Whether this coincides with the limits of the Rio Grande embayment of Lower Eocene time cannot be stated. The deposits of the Middle Eocene, however, extend south through the basin of the Conchos River.

From the evidence before us it appears that following the close of the Wilcox deposition there was a period of elevation and erosion, succeeded at the beginning of the Lower Claiborne by a rather rapid incursion of the sea which transgressed the earlier Tertiary area in places and allowed the deposition of the Carrizo sands. During the succeeding sub-stages of the Lower Claiborne there was a gradual sinking

of the eastern face of the Tamaulipas Range, permitting the later deposits to overlap the earlier, and its close was marked by gradual dessication and the formation of the numerous beds of gypsum found in the Frio clays. Here, as in Texas, no beds have been recognized which are in any way referable to the Upper Claiborne.

#### UPPER EOCENE

Between the exposures of the Frio on the Rio Grande and southward and the first deposits clearly referable to the Oligocene there is quite a belt of country, largely covered by the Reynosa. It is entirely possible that within its limits there may exist representatives of the Upper Eocene or Jackson such as occur in eastern Texas, but which are apparently entirely wanting in the valley of the Rio Grande. The only deposits actually observed that seem in any way related to this period were found overlying the Frio on the road from China to Laguna de los Indios. The Frio clays and soft shaly sandstones formed the country rock from Chilarios southeastward for some distance. No change in character of deposits were seen for 24 miles, but at a so-called Mina Antigua some three miles southeast of Rancheria, the old shaft, 20 feet deep with tunnel to east of 40 feet, showed principally sands. The tunnel was in a bed of coarse-grained bluish sand carrying pyrite, gypsum, and sulphur and entirely different from any Frio materials. From this point to Laguna de los Indios, some 18 miles, the surface is sandy. The well at the ranch is 80 feet in depth, the materials through which it was sunk being coarse-grained bluish sand with gypsum similar to that found at the old mine. The sand was here interbedded with yellow clay which carried a number of poorly preserved fossils. Dr. W. H. Dall, who looked them over, stated that they contained a *Pecten* recalling *P. poulsoni*, *Tellina* and *Cardium* or *Venericardia*, which, while not characteristic, seemed to indicate an Upper Eocene or Oligocene horizon. This may prove to be the southern extension of the Jackson of east Texas. Similar sands covered by the Reynosa occur also in ridges northwest of the ranch.

## OLIGOCENE

Overlying the beds we have here referred to the Eocene, we find a series of yellow sands, clays and calcareous beds which carry an Oligocene fauna. We have called these the San Fernando from the fine exposures of the beds in the vicinity of the town of that name on the Conchos River. As will appear, these beds all belong to the Upper Oligocene and up to this time no beds of the Lower Oligocene, like those of the Buenavista River region with *Orbitoides papyracea*, etc., have been recognized in the area north of the Tamaulipas Range. From our present knowledge it would seem that while the Lower Eocene deposits show a gradual overlapping southward until the Conchos is reached, the Oligocene, on the contrary, shows an overlapping northward to the same region, so that along the Conchos the uppermost beds of the Oligocene are in contact with the members of the Eocene there exposed.

In the region of San Jose de las Rusias,<sup>†</sup> which occupies the extreme southern portion of this area, we have numerous exposures of the Upper Oligocene. It apparently immediately overlies the Cretaceous and is penetrated by eruptive rocks which are connected with or extend eastward from the Tamaulipas Range. In places these eruptives are of a porphyritic texture but at others they are basalts. They occur as masses, ridges or isolated peaks throughout the region and the Oligocene beds in immediate contact with them are more or less metamorphosed and show at times considerable dips. These eruptive rocks, in places, extend to within two or three miles of the Gulf coast.

The lower beds of the Oligocene in this region are yellow clays, which are altered in places and appear as hardened shales, and clayey limestones carrying *Cristellaria*, *Nummulites*, corals and molluscan forms followed by yellow sands and clays with an extensive fauna. The beds have a general southeast dip. At San Rafael on the Zarzizal River at the extreme southern end of the district, the contact of the eruptives with the yellow clays is well shown.

Northward of San Rafael toward the ranch of San Jose de las Rusias, the principal exposures are of eruptive rocks,

<sup>†</sup> An excellent description of this region will be found in "Boletin del Instituto Geologico de Mexico," No. 26, Juan D. Villarejo.



porphyries and basalts, with occasional outcrops of the hardened shale and the yellow clays of the Oligocene.

Lying four to six miles east of San Rafael there is a range of hills 300 to 400 feet in height, composed of alternating beds of yellow clays and clayey limestones carrying poorly preserved molluscan forms together with great numbers of *Cristellaria*, corals, and some *Nummulites*. Among the corals collected here, Dr. T. W. Vaughan determined *Favosites* (?) *polygonalis* Duncan, *Goniastrea antiguensis* Duncan, *Acropora* (?) sp., *Orbicella*, n. sp., and *Goniopora*, sp., very similar to or identical with an Antigua species. These, he says, indicate an Upper Oligocene horizon about equivalent to the Chatahoochee of Georgia.

To the east of this range stretches an open prairie country in which there is a ridge of eruptive material (basalt) which runs parallel with the range of hills and has a width of five miles. To the east of this eruptive ridge and only two miles from the Gulf shore a sandstone was found very similar in character to those of the *Pecten* bed on the Conchos and carrying the same *Pectens*.

Around the San Jose de las Rusias Ranch the beds which are exposed show considerable disturbance. Immediately at the ranch the beds, which are fossiliferous sandstones, dip northwest at a high angle. Northeast of the ranch a hill 60 feet high shows beds of yellow clay overlain by hard calcareous sandstone which weathers into rounded masses. A great number of corals occur within the clays and in the sandstone. Dr. Vaughan reports *Orbicella cellulosa* Duncan, and *Meandrina*, n. sp. from this locality. A short distance north of this hill is another in which the basalt has come up through the Oligocene beds which are here impregnated with asphalt. To the east of the ranch, some few miles, there is a range of hills 400 feet high capped with the Coquina, and lying to the east of the range another volcanic hill. North of the Soto la Marina the same clays and limestones occur and east of the Salitre Ranch, the same *Orbicella* was found as that occurring southeast of San Rafael, together with specimens of a new genus of the fungid corals. At and around Salitre were found three species of echinoderms, the

only ones so far found in beds we have recognized as Oligocene. The following is a section of the deposits near Salitre:

	Feet.
Coarse gray sandstone.....	20
Yellow clay, fossiliferous.....	100
Hard yellow clayey limestone, fossiliferous.....	4
Yellow sandy clay .....	10
Yellow sandstone, fossiliferous .....	8
Yellow clays and sands .....	10

A range of hills known as the Martines which are similar to those seen east of San Jose de las Rusias and of about equal height is found here extending from Salitre southward nearly to the Soto la Marina River. Along the Conchos River the exposures of the Oligocene are of beds higher in the series than the bulk of those of San Jose de las Rusias, being represented in that region by the Pecten beds which lie along its extreme eastern border. In the valley of the Conchos the greenish clays and soft sands with their beds of gypsum, which are part of the Frio, are found as far east as Tepetate and forming the body of the hills lying directly north. Beds of the Oligocene are found not only overlying these beds at this point, but stretching several miles westward, showing a clear overlap to lower beds of the Eocene section.

What seem to be the lowest beds of the San Fernando section were found three miles west of that town, and consist of cross-bedded gray sandstones with a thickness of 60 feet. Half a mile east the beds form a series of falls in the river and we have the following section:

	Feet.
Conglomerate .....	4
Cross-bedded sandstone indurated and with bands of fossils .....	70
Yellowish sandstones with fossils.....	3
Gray sandstones, weathering in holes, few fossils	4

The cross-bedded sandstone carries a great number of a large Pecten, which are well preserved and, as it appears to be a well marked horizon, we have called it the Pecten bed. It is immediately overlain by beds of sandy clay with fragments

of shells, a well preserved large gasteropod, and numerous claws of a crustacean. These beds continue down the river. A bluff opposite San Fernando shows:

	Feet.
Reynosa .....	20
Yellow clay .....	20
Yellow sandy clay with many fossils.....	4
Cross-bedded sandstone .....	30

The river here runs south almost with the strike of the beds; thus the same or similar beds are seen for three or four miles down-stream, when the river again swings east. Here the clayey sands seen at the falls above the *Pecten* bed carry not only the large gasteropod and crustacean claws, but grahamite and fragments of lignite also. Hills a mile east of this locality are composed of soft yellowish sandstone and clay beds with a *Coquina* limestone on top. Still south of this a section one-half mile east of Algodones shows heavy beds of yellow sandy clay overlain by yellow clay containing casts of fossils and many valves of *Pecten*. This was followed by another bed of yellow clay and this by a series of calcareous sands and silicious gravel 20 feet thick with numerous casts of a *Cardita*-like shell and single valves of large oysters which appear to have been transported. The same beds are also found in the hill one mile north of Algodones and extending two miles or more to the eastward. These Oligocene sands and clays also form the body of the hills north of San Rafael, on the Conchos, and the eastern flank of the Pomeranes. To the north and east of this locality their extension is largely hidden by the Reynosa covering.

#### NEOCENE

##### *Coquina Limestone*

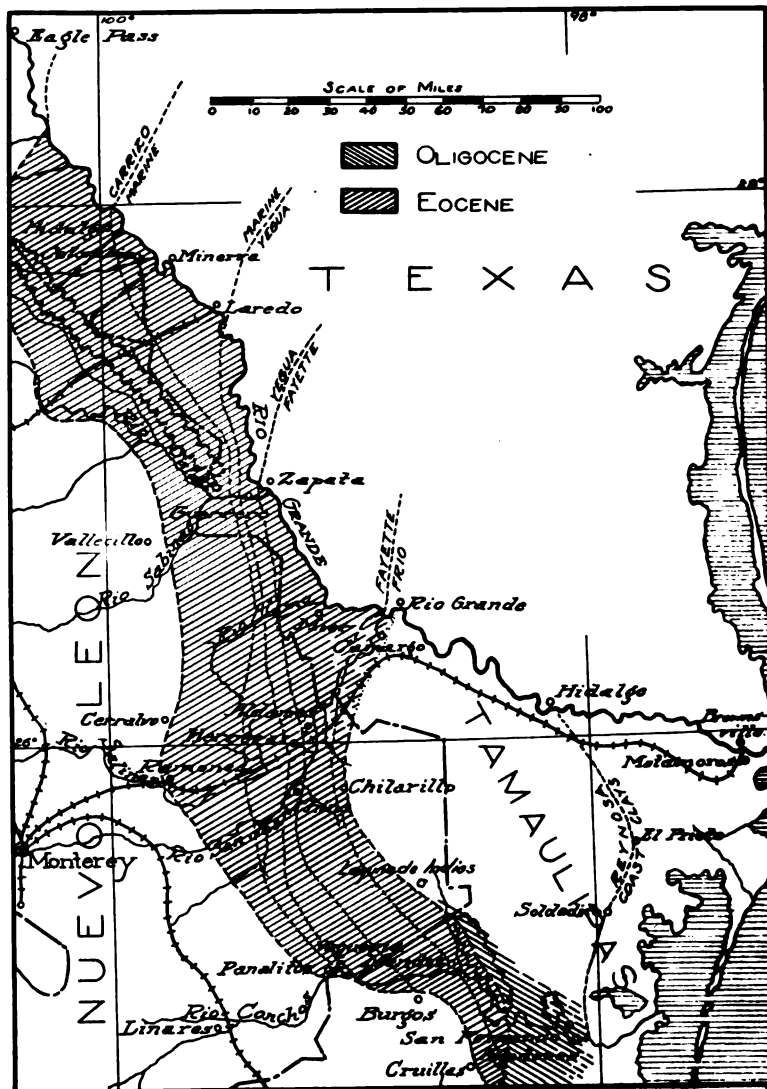
Overlying these fossiliferous sands and sandy clays of the upper San Fernando, which seem to have a thickness of 300 feet or over, we find a bed of *Coquina* limestone, or possibly a succession of such beds. Half a mile east of the bluff near San Fernando, the *Coquina* limestone was found overlying the beds of the section as already given, and similar *Coquina* is found near San Diego, capping a small hill and occupying

the valley of the river for two miles to the southeast. This is more than 20 miles west of the exposure of any beds we have so far recognized as Oligocene. The Coquina was also seen west of Chorreras, where it apparently rests upon the Fayette and between Abasolo and Soto la Marina in contact with the Cretaceous. In the San Jose de las Rusias region it was also observed in several places forming the tops of the hills. It is probably of Neocene age.

### *Reynosa*

The eastern border of the outcrop of the Reynosa limestone was traced by Professor Cummins from Reynosa southward to the Conchos River in the vicinity of Rinconada. From this border the Reynosa spreads westward covering more or less of the area underlain by the Tertiaries here described, and in places extends to the foot of the Sierra Madre. One of the best exposures seen was at Abasolo in the Soto la Marina River, where the Reynosa (overlying 60 feet of blue Papagallos shale) shows 40 feet of a conglomerate of blue limestone pebbles overlain by 60 feet of tuffaceous limestone. Many good sections of it were secured from the logs of water wells in the area. At several places small basins were found in it, in which deposits of *Equus* bed material and fossils occur as they do around San Diego, in Duval County, Texas.





AREAL DISTRIBUTION OF THE EOCENE DEPOSITS  
OF NORTHEASTERN MEXICO.



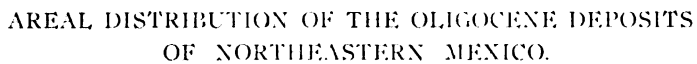
AREAL DISTRIBUTION OF THE OLIGOCENE DEPOSITS  
OF NORTHEASTERN MEXICO.







Fig. 1—ESCONDIDO SANDS AT KINGFISHER CROSSING,  
RIO GRANDE.



Fig. 2—PAPAGALLOS SHALES OVERLAIN BY REYNOSA ON  
SALINAS RIVER.





FAYETTE OVERLAIN BY REYNOSA ON CONCHOS  
RIVER.



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**MAY 4, 1916**

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**VII**  
**REPORT OF THE PRESIDENT OF THE ACADEMY**  
**FOR THE YEAR 1915**

**BY**  
**C. E. GRUNSKY**  
*President of the Academy*

For the year which has just closed the Academy can again record progress. The construction of the Museum building in Golden Gate Park had been sufficiently advanced in August, 1915, to make possible a transfer of the Academy's collections, of its library, and of its offices, from the temporary quarters of the last few years at No. 343 Sansome Street.

This annual meeting is notable, therefore, because it is the first annual meeting, and in fact, the first meeting, at the Academy's new quarters in its Museum building in Golden Gate Park. It may be well in passing again to call attention to the fact that the privilege to build here was granted by the people of San Francisco at a public election on November 15, 1910.

The Academy has planned a building which is specially adapted to Museum purposes but which will also afford adequate space and facilities for research work and for the storage and preservation of research material.

Of the proposed building a first section only has been erected, covering about one-third of the ground space which it is proposed ultimately to occupy. The cost of the building

**May 4, 1916**

**LIBRARY OF THE**  
**NATURAL HISTORY MUSEUM**  
**STANFORD UNIVERSITY**

to February 1, 1916, has been in round numbers \$175,600 of which all except about \$125 has been paid.

The building has not yet been opened to the public, but it is expected that the installation of the habitat groups of mammals and of birds will have been sufficiently advanced to justify a formal opening sometime in May of this year.

The acceptance by the Academy of the offer of Mr. Wm. M. Fitzhugh to exhibit in the Museum building the Fitzhugh-Lowe collection of Indian baskets, Indian stone implements and related articles, has resulted in a well filled hall whose contents are most attractive and instructive. I desire to record at this time not only the Academy's appreciation of having this valuable collection added to its museum, but also the fact that the entire installation including the exhibition cases was made at the expense and under the personal supervision of Mr. Fitzhugh. The Indian baskets in this collection are said to constitute the largest and most complete exhibit of the kind in existence.

Owing to lack of suitable cases and space the Hemphill shell collection remains largely boxed, but it is hoped that something may be done soon toward making it available for study and a portion of it for exhibiton.

The Academy found opportunity to be represented, in a small way, at the Panama-Pacific International Exposition, where, in the Food Products Building, space was secured for a joint exhibit by the Academy and the California Fish and Game Commission. While the allotted space, the best that was available, was altogether too restricted for results that might otherwise have been secured, the exhibit, prepared with material from the Academy's stock by and under the direction and supervision of Mr. John Rowley of the Academy, was nevertheless an effective, attractive display which forecasts what we are now beginning to realize in the habitat groups that are being installed in this building.

The Academy has received a number of valuable donations from the Panama-Pacific International Exposition Company and from various countries which were represented at the Exposition. Full reference to these will be made in the report of the Director of the Museum, and I wish only to say that the Academy is sincerely appreciative

of the good-will which these donations manifest and that it will make the best possible use thereof. Australia, Argentina, New Zealand, China, Japan, Honduras, Guatemala, and the Netherlands are among the contributors. These donations consist largely of minerals and woods, and many other objects, including some desirable pieces of furniture. Similar donations were received from various states, including California, Montana, Missouri, Idaho, Oregon, and Washington. The government of Porto Rico gave a good relief map of Porto Rico and nine excellent large photographs of Porto Rican natural scenery.

A fine specimen of the Florida Manatee was donated by the late Mr. Warren Frazee ("Alligator Joe"), at the suggestion of Mrs. Nellie Waterhouse Dorne, one of our members. The skin and skeleton have been saved.

A large number of valuable specimens and desirable cases and tables were received from the U. S. Bureau of Fisheries.

A large series of minerals, woods, etc., has been contributed by the various Sacramento and San Joaquin Valley County Associations.

The many other donations made during the year to the Academy's museum and library are too numerous for enumeration in this report. They will be referred to in more detail in the report of the Director of the Museum.

The publications of the Academy cover Parts I to VI of Vol. V of the Fourth Series of Proceedings, in all 193 pages.

The activities in the various departments during the year are fully set forth in the reports of the Director of the Museum and of the several curators, and do not require repetition. It need only be stated that the large and continuing demand upon the Academy's financial resources for the installation of the exhibits, has made it necessary to keep the allotments for work in these departments at the lowest possible amounts. The Academy is not in command of resources, in other words, that would enable it to do all that an institution of its character should do for California, for the Pacific Coast, and for the entire Pacific Ocean region.

The curator of botany has been active during the year in enlarging and caring for the herbarium to which many important additions have been made.



The department of paleontology has been very active. Many additions to the collections have been made and several scientific papers based on the department's collections have been published or prepared.

The curator and assistant curator of herpetology have the immense collections of that department installed on shelving and have done much toward increasing the collections.

A few accessions have been received by the departments of mammalogy and ornithology and a beginning has been made with the department of invertebrate zoology.

The curators and their assistants have been alert and efficient in caring for the collections in their charge and their earnestness and enthusiasm deserve and should receive the encouragement of the community and of the entire Pacific Coast.

We may hope that the high class work that is being done, of which some samples of educational value will soon be on display, will attract the attention of the public, and will make clear that ours is an institution for service worthy of generous support by those whose means will permit.

Our building will quickly be filled to capacity. We already know that we will be short of space to display all that has been collected and prepared for attractive educational exhibits.

The Academy's thanks are due, and I take pleasure in expressing them, to those who are devoting of their lives to the scientific and educational work under the Academy's guidance and for which the Academy can provide only inadequate compensation.

The interest displayed in their work, combined with the high order of skill, ability and talent possessed by those who are installing the habitat groups in our Mammal and Bird halls, may be accepted as an assurance that these exhibits will have artistic merit ranking with the best that has yet been produced.

The courtesy of the Mechanics Institute has made it possible to hold the Academy's stated monthly meetings since August at the Mechanics Institute. Up to the present time the Council has not deemed it wise to arrange for these meetings in the Museum building, whose auditorium is not yet ready

for them, and which lacks the convenience of location which can be claimed for the Mechanics Institute.

On behalf of the officers of the Academy I wish to express their appreciation of the help received from members and friends in advancing the Academy's work, and as President I wish to thank all who have in any way contributed to extend the Academy's usefulness.

The present total membership in the Academy is 472, made up of:

Honorary Members .....	27
Life Members .....	86
Resident Members .....	359

During the year 1915 there was an accession of 63 new members, and the Academy lost by death 6, by resignation 25, and by being dropped for arrearages in dues, 9. The net gain in membership during the year has been 23.

The losses by death were:

Greene, Prof. Edward L.....	Life Member .....	November 10, 1915
Günther, Dr. Albert.....	Honorary .....	1914
Hilgard, Prof. Eugene W....	Honorary .....	January 8, 1916
Holladay, Mr. S. W.....	Life .....	February 16, 1915
Putnam, Prof. Frederic W....	Honorary .....	August 14, 1915
Wilson, Mr. J. C.....	Resident .....	1915

#### LECTURES

During the year 1915, 14 free lectures have been delivered at the stated meetings of the Academy, as follows:

JANUARY 18.	"The Significance of Glaciation in Geologic Time." Dr. Marsden Manson.
JANUARY 29.	"The Work of the United States Biological Survey." W. L. McAtee, U. S. Biological Survey.
FEBRUARY 17.	"Explorations of a Sacred Cave in Arizona." Dr. Walter Hough, Curator of Ethnology, United States National Museum.
MARCH 17.	"Liquid Air." Prof. E. C. Franklin, Professor of Chemistry, Stanford University.
MARCH 26.	"International Peace." Chancellor David Starr Jordan.

- APRIL 21. "Physiographically Unfinished Entrance to San Francisco Bay."  
Dr. Ruliff S. Holway, Professor of Geography, University of California.
- MAY 19. "The Status and Life History of the Tree Mouse, *Phenacomys longicaudus* True."  
Dr. Walter P. Taylor, University of California.
- JUNE 16. "The Food of the Roadrunner in California."  
Dr. Harold C. Bryant, University of California.
- JULY 21. "The Lessons of the Southeast Wind."  
Dr. Marsden Manson, San Francisco.
- AUGUST 18. "Administration of Fish and Game Laws."  
Ernest Schaeffle, Secretary California Fish and Game Commission.
- SEPTEMBER 15. "Snap-shots in Brazil."  
Prof. E. C. Starks, Stanford University.
- OCTOBER 20. "Pearls and Pearl Culture."  
Prof. Charles A. Kofoid, University of California.
- NOVEMBER 17. "Some Fishes and Fishing in California and Nevada."  
Prof. John O. Snyder, Stanford University.
- DECEMBER 15. "Ancient Climates of the West Coast."  
Dr. James Perrin Smith, Stanford University.

#### FINANCIAL

The financial transactions of the Academy are fully set forth in the Treasurer's report and in the financial records. From these it appears that our gross annual income is about \$67,500, of which about \$46,272 is the net return from the Academy's Market Street property and about \$1500 is the amount received from members as admission fees and dues. The Academy has recently borrowed the sum of \$32,175 in order to advance the completion of its building and the installation of exhibits. The total obligations on which interest is now being paid is in round numbers \$332,000.

The gross annual receipts from the Market Street property for twelve months are about \$64,272, and the interest on the \$300,000 for which this property is mortgaged to the New York Mutual Life Insurance Company is \$18,000, leaving the net annual return from this property \$46,272, as above stated.

The expenditures in the calendar year 1915 will give some idea of how the available funds, apart from the investment in the Museum building and in exhibits, have been used. The amount of interest paid was \$18,257.05, and interest received

was \$1,633.28. The salaries paid during the year amounted to \$15,705.35; the insurance paid was \$2,120.03, and the general operating expenses were \$3,339.94.

These figures show that about \$28,000 of the Academy's receipts were available in 1915 for construction and installation of exhibits and that a fair annual surplus may be expected which, after a year or two, will in part be available for reducing the Academy's financial obligations.

The fact that it has been necessary to thus anticipate for a period the usual surplus should cause no regret. We know that the time will come when the results achieved will fully justify the course which has been pursued.



## VIII

### REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1915

BY

BARTON WARREN EVERMANN

*Director of the Museum*

At the time of the last annual report of the Director of the Museum (January 4, 1915), construction work on the new Museum building had been stopped. The hope was expressed that the difficulties with the contractors would soon be adjusted and that the work might be resumed at an early date. This hope was realized. A satisfactory adjustment was made and building operations were resumed early in March. The work proceeded with reasonable celerity and the research wing was ready for occupancy the last week in August. During the last days of August the offices and research collections were transferred from the temporary quarters at 343 Sansome Street to the new Museum building. The Sansome Street quarters were given up and the rent ceased August 31, 1915.

Construction work on the three exhibition halls continued with reasonable speed. The connecting corridor was completed early in September and the installation of the Fitzhugh-Lowe collection of Indian baskets, pottery and stone implements was begun at once and completed in December. This collection consists of a total of about 15,000 specimens, of which practically all except duplicates have been placed on exhibition. The space available for this exhibit has been completely utilized; indeed, the objects now on display are in many cases too crowded for the best effect. Considerable additional space will be needed if the entire collection is to be properly exhibited.

The Academy is indebted to the public spiritedness and generosity of Hon. Wm. M. Fitzhugh for the opportunity to put this splendid collection on exhibiton.

The California Mammal Hall and the Bird Hall were completed in December and the installation of the habitat groups was at once begun. Considerable progress has already been made.

## ELK DISTRIBUTION

In the fall of 1914 the Academy, with the coöperation of Messrs. Miller and Lux and the Southern Pacific and Santa Fé railroads, undertook to distribute a portion of the Kern County herd of elk to suitable reservations in the State. A total of 54 animals were distributed, as set forth in detail in the Director's report for 1914. In the fall of 1915 this conservation work was again taken up. Messrs. Miller and Lux again built a large corral on their alfalfa land near Button-willow, in which they succeeded in trapping about 100 elk, mostly females and young, of which 92 were distributed by the Academy in November and December, as follows:

Thomas Jacob, Visalia, for Mooney Park, near Visalia, 1 male and 3 females.

W. C. Claybaugh, for Fresno City Park, 1 female.

A. V. Lisenby, Fresno, for large reservation near Friant, 1 male and 2 females.

P. H. Loinaz, Fresno, for private park near Fresno, 1 male and 1 female.

John Zapp, Fresno, for private park near Fresno, 1 male.

Walter L. Chrisman, San Jose, for Alum Rock Park, 2 males and 2 females.

A. T. Hain, Cook, California, for Vancouver Pinnacles Reservation, 1 male and 3 females.

J. F. Dunne, Gilroy, for a 15,000-acre reservation near San Felipe, 1 male and 4 females.

P. C. Morrissey, Santa Cruz, for Laveaga Park, Santa Cruz, 2 males and 4 females.

H. L. Middleton, Boulder Creek, for the California Redwood Park, 4 females.

Park Commissioners, Sacramento, for Del Paso Park, 3 males and 9 females.

Park Commissioners, Petaluma, for City Park, 2 males and 10 females.

Henry D. Nichols, San Francisco, for large reservation at Eden Valley, near Willits, Mendocino County, 2 males and 10 females.

Park Commissioners, San Diego, for Balboa Park, 3 males and 19 females.

Some of these shipments are regarded as experimental. It is not certain that the elk will do well in all the places to which they were sent. This is particularly true of the northern shipments to Sacramento, Petaluma, and Mendocino County, although reports received from Sacramento and Petaluma state that their elk are doing well. A report recently received regarding the Mendocino shipment is not so favorable. Nine of the 12 have died. The winter there has been unusually severe, with unprecedentedly heavy snow. It is believed that the climatic conditions in that part of the State are too severe for this species, whose natural habitat is further south in a milder climate.

The reports regarding the shipments of 1914 are uniformly favorable. They indicate that the elk are doing well in all places. The animals have grown markedly, several fawns have been born, and all are in good condition.

It is hoped and believed that these transplantings will aid materially in preventing the extinction of this interesting species of big game.

#### DEPARTMENT ACTIVITIES

Owing to the demands of building, moving and installation, the activities of the respective departments were necessarily greatly restricted. Getting the collections ready for transfer, then the actual moving, followed by the installation in the new quarters, engaged the curators and their assistants during the larger part of the year. Nevertheless each department was able to accomplish considerable additional work of importance.

1. *Department of Herpetology.*—The assistant curator spent several weeks engaged in field work in southern California which resulted in considerable additions to the collections. During the year the total number of specimens in this department was increased from 31,470 to 32,280. Among the additions is a specimen of the very rare species of gigantic land tortoise of Aldabra.

In spite of the work and confusion incident to moving, the regular routine work of caring for the collections has progressed, and much has been done in the way of classification, labeling, arranging, and card cataloguing.



A paper dealing with the amphibians and reptiles of Utah was completed by the department and published in June. Other scientific papers based on the collections are in course of preparation. A vivarium has been constructed on the roof of the rear exhibition wing in which various species of reptiles and amphibians are kept for observational purposes.

2. *Department of Entomology*.—No successor as assistant curator has as yet been appointed to the late Mr. Charles Fuchs, and the department has therefore been without the services of a preparator. The collections have been inspected from time to time, and they have been enriched by a number of considerable donations, as listed in the appendix to this report.

Certain series of specimens have been assigned to specialists for study and report.

The proper building up and care of the collections in this department require the employment of additional help and it is hoped this can be done.

3. *Department of Ornithology*.—The very large and valuable collection of birds is now installed in suitable cases in the new building. No field work was done by the department in the year, and, as a consequence, only a few minor additions to the collections have been made. Mr. Loomis has made constant use of the Tubinares of the collection in connection with the preparation of a monograph on that group of birds upon which he is engaged.

4. *Department of Mammalogy*.—The acting curator and his assistants during the year gave practically all their time to the preparation of materials for the habitat groups which are now being installed. No field collecting was done except incidental to other work. Some specimens, however, were obtained, especially in connection with the moving of the elk.

5. *Department of Invertebrate Zoology*.—This department was reestablished only a year ago, and only a small allotment was made for its use. This fund has been expended in part in starting the making of a synoptical series of the marine invertebrates of the California coast.

6. *Department of Invertebrate Paleontology*.—Mr. F. M. Anderson, the curator of this department, was absent on leave during the year, engaged on certain special work for a large

oil company in Colombia, South America. Under the immediate direction of the assistant curator, the department has been active in building up and caring for the collections, and in carrying on research work. The months of April to June were chiefly devoted to packing the collections preparatory to moving. During August and September the collections were moved, unpacked, and installed in the cases in the new building. Although these duties required a great deal of time, opportunity was found to do some field work. Two trips were made to the Petaluna Quadrangle, which resulted in clearing up a number of the problems concerning the geologic history of that region.

During the year the Academy published a paper prepared by the assistant curator dealing with the Fauna of the Type Tejon, and its relation to the Cowlitz phase of the Tejon group.

The Academy also published a paper by Dr. E. T. Dumble, based partly on Academy material, on the Tertiary deposits of Northeastern Mexico. Three other papers based in part on the collection of this department have been completed and accepted for publication, and at least two others are in preparation.

Many and valuable additions to the collections of this department during the year, most of them being donations by various exhibitors at the Panama-Pacific International Exposition. These are set forth in detail in the appendix to this report. Mr. F. M. Anderson and Mr. Bruce Martin made extensive collections at Gatun, on the Panama Canal, and on the north coast of the United States of Colombia. These collections include both recent and fossil shells and constitute a valuable addition to the department's research materials.

Professor Yabe of the Imperial University of Tokyo has already given the Academy an excellent collection of Pleistocene and a few Cretaceous fossils from Japan, and an exchange of other specimens has been arranged.

Arrangements have been made whereby the California State Mining Bureau will instal in the Museum a comprehensive exhibit illustrative of the mineral resources of the state. The Standard Oil Company has offered to instal an exhibit of models, charts, etc., that will, it is believed, prove of great edu-

cational value in elucidating a number of the more important and popular phases of the oil industry.

7. *Department of Botany*.—The usual activity has been displayed by the curator in caring for the herbarium and securing accessions to it. During the year there have been added to the herbarium 2220 mounted sheets representing 1241 species new to the collection. The herbarium now contains a total of 20,586 mounted sheets representing 7997 species, all properly arranged in the herbarium cases. Besides these there is a large number of specimens not yet mounted. There are also 475 fungi types in envelopes arranged alphabetically in boxes. These were saved from the fire of 1906. Besides these there are 1136 specimens of phanerogams containing 711 types and 96 cotypes saved from the fire. Besides these, certain other specimens were saved from the fire because of the fortunate circumstance that they were loaned at the time. They are as follows: A large bundle of *Gilias* returned from Germany, and containing many types; a bundle of *Ptelea* returned from Washington; some specimens of *Eschscholzia* which had been loaned to the late Dr. Edward L. Greene; and most of the Academy's specimens of *Lupinus* and some of *Delphinium* which had been loaned to the Gray Herbarium, all of which have been returned. All these specimens saved from the fire fill one herbarium case in which they are now installed.

Owing to the inexcusable failure of the author of the reports on the Galapagos plant collections to correlate properly his published identifications with the specimens, the curator has found it necessary to go over the entire collection and identify each specimen anew. This has entailed a vast amount of work.

Within the year the curator made a number of brief collecting trips, as follows: One to the region of the San Antonio and Nacimiento rivers near Jolon in Monterey County, and to Aromas in San Benito County; one to Mt. Diablo; one to Mt. St. Helena, Calistoga, and the Petrified Forest; one of a week's duration in the foothills of Mariposa County; one to Bodega Point, the type locality of many species; and finally, a brief trip to Los Angeles and San Diego. All these trips were brief and were

made at very little expense, the total amounting only to about \$70.00.

Mention should be made of the valuable voluntary service which Mrs. Marian L. Campbell, Mrs. G. Earle Kelly and Mrs. Elizabeth Parsons Hawver have rendered the Academy. Mrs. Campbell has mounted 6434 sheets of herbarium specimens. Mrs. Kelly has mounted 218 sheets of specimens from the Grand Canyon. And Mrs. Hawver has put the collection of ferns in order. The fern collection contains a great many exotic genera and species, some donated by the Philippine Bureau of Science, some donated by Doctors Fred and Charlotte Baker, and a fine collection of 100 Hawaiian ferns donated by Mrs. Zelia Nuttall.

The curator has continued her excellent work with the Botanical Club and with the Park gardeners. The Botanical Club holds weekly meetings at the Academy or in the field. The Gardeners' class also meets once a week at the Park Lodge.

8. *Department of Exhibits.*—This department has been busy during the year preparing the large habitat groups of mammals and birds which are now being installed. One of the assistants was detailed for a considerable portion of the year to duties in connection with the building operations and, later, for a few weeks in connection with the elk distribution.

The installation of the large habitat groups has begun. The Antelope, Mule Deer (winter scene), and Steiler's Sea Lion groups are nearing completion. The backgrounds are practically done, the animals are in place, and the accessories will soon be finished. Work has begun on the California Sea Lion and the Farallon Bird groups, and it is hoped they may be completed within the next two months. Then the Leopard Seal, the California Valley Elk, the Desert Mountain Sheep, the Mountain Lion, the Black Bear, and the Los Baños Bird groups are all ready as to materials, and the Desert Bird group is ready except as to a part of the accessories.

It is intended to place in the Mammal Hall six additional groups, viz: the Buro Deer, the White-tail Deer (fall scene), Humboldt Elk, Fur Seal, Coyote and Wild Cat, but the materials for these have not yet been collected. The animals for an Elephant Seal group are ready, but there is no suitable place in which to install the group. The same is true of the Win-

ter, Spring, Summer and Fall groups of the Black-tailed Deer. The animals and accessories are all ready, but there is no suitable place in which to place them. The animals are also on hand for two Gigantic Land Tortoise groups, but the accessories have not been prepared and there is no suitable place for the groups unless two of the spaces in the Bird Hall be utilized for that purpose.

The present situation regarding the habitat groups is therefore as follows:

- a. Groups for which practically all animals and accessories are prepared and which will be completed within the next few months: Steller's Sea Lion, California Sea Lion, Leopard Seal, Antelope, Mule Deer (winter scene), California Valley Elk, Desert Mountain Sheep, Mountain Lion, Black Bear, Farallon Bird group, and Los Baños Bird group.
- b. Groups for which all the animals and accessories have been prepared but for which there is no suitable place in which to install them: Four seasonal groups of the Black-tailed Deer.
- c. Groups for which the animals but not the accessories have been prepared, but for which there is no suitable place for installation: Elephant Seal group.
- d. Groups for which most of the animals and accessories have been prepared and which with a little more collecting can be installed: Desert Bird group.
- e. Groups for which the animals are on hand and some of them mounted, for which the accessories are needed and for which there is no suitable place for installation unless space in the Bird Hall be used: Two Gigantic Land Tortoise groups.
- f. Groups for which suitable places for installation have been provided but for which the animals have not been collected nor the accessories prepared: Buro Deer, White-tailed Deer, Humboldt Elk, Alaska Fur Seal, Coyote, and Wild Cat.

It is the intention to endeavor to collect this spring and next fall the animals required for the Alaska Fur Seal, the

Humboldt Elk, the Buro Deer, and the needed accessories for the Desert Bird groups.

It is also intended to begin the preparation of groups of small mammals and birds to go in the small spaces back of the large panels at the ends of the large groups. There are spaces for 34 of these small groups, 22 in the Mammal Hall and 12 in the Bird Hall. The animals are on hand for only one of these groups (the California Striped Skunk), but it is hoped that materials for several others may be obtained within the year. It is also desired to begin the preparation of small portable groups or exhibits suitable for loan to the schools. These will include not only groups of small mammals and birds, but of other animals and of plants, minerals, etc. It is hoped to make this one of the prominent activities of the Museum.

*Exhibit at the Panama-Pacific International Exposition.*—When the contracts were let for the Museum it was hoped that the building would be completed by the beginning of 1915 and that a number of habitat groups and other exhibits could be installed early in the year. In view of these probabilities it was decided not to make any exhibit at the Exposition, but to endeavor to have the Museum far enough along to attract a fair proportion of the Exposition visitors. Owing to unexpected delay in building operations this hope was not realized.

The California State Fish and Game Commission desired to make an exhibit at the Exposition, but did not possess suitable materials. Coöperation between the Commission and the Academy was suggested, with the result that an agreement was entered into whereby the Academy would furnish and install the materials and the Commission would meet the expense. This arrangement was carried out and a joint exhibit was installed in the Food Products Palace. The exhibit consisted of the following: A Desert Mountain Sheep group, a Summer Deer group, a Mountain Lion den, a Black Bear den, a hunter's camp, an aquarium, and various minor exhibits. This was completed early in the summer and proved to be one of the most interesting and attractive exhibits of the entire Exposition. There was seldom an hour during the continuance of the Exposition that a large number of visitors could not be seen admiring the various units of this exhibit, and many expressions of approval and appreciation were heard.

## ACCESSIONS TO THE MUSEUM

The accessions to the Museum during the year have been many and varied, as shown by the detailed list in the appendix to this report. Most of the accessions have been donations received from exhibitors at the Panama-Pacific International Exposition, among whom may be here mentioned the following: The governments of Argentina, Australia, Bolivia, China, Cuba, Guatemala, Denmark, Honduras, Japan, New Zealand, Norway, the Netherlands, Porto Rico, and Sweden. Important donations have also been received from the following: The U. S. Bureau of Fisheries, the U. S. Geological Survey, the states of Idaho, Montana, Washington, Oregon, Missouri, Louisiana, and New York; also from the Standard Oil Company, the Sacramento Valley Counties Association, the San Joaquin Valley Counties Association, and the Anaconda Copper Company. Considerable donations of cases, matting and other articles have been received from the Exposition Board.

## LIBRARY

About 3000 linear feet of metal book stacks have been installed in the library, which occupies rooms on both floors at the south end of the research wing—a room with 846 square feet of floor space on the second floor and one with 1344 square feet of floor space on the first floor, or a total of 2190 square feet.

The books are now being arranged on the shelves according to the Library of Congress Classification, and a good start has been made with the accession list.

## RECOMMENDATIONS

*Addition to the Museum Building.*—It is already evident that the present museum building is wholly inadequate for housing the collections and exhibits of the Academy already on hand. For example, there is no place for the following habitat groups already prepared: Elephant Seal group and the four seasonal groups of the Black-tailed Deer. There is no suitable space for the two groups of Gigantic Land Tortoises and the Iguana, for which we already have the materials, nor for

the 86-foot Sulphur-bottom Whale skeleton. Nor is there any room for suitably displaying any of the many large and very interesting collections of minerals, ores, woods, and other objects received from the Exposition; we have not even storage room for many of the exhibition cases, tables, etc., received from the Exposition.

In order to relieve this congestion, to avoid the necessity of placing exhibits in halls in which they do not logically belong, and to enable the museum to place on exhibition habitat groups and other exhibits already prepared or available for preparation, an additional hall is immediately necessary. Perhaps the most practical and economical thing to do would be to glass over and close in the court between the two rear wings. According to estimates gotten a year ago, this could be done for about \$9000.00. It would doubtless cost more now owing to the increased cost of materials. To close in the court and provide a second floor or balcony which would greatly increase the exhibiton space, provide the necessary cases, etc., would now probably require a total of about \$20,000.

An alternative would be the construction of a hall across the rear corresponding to the Mammal Hall. This addition would have the same dimensions as the Mammal Hall, but should be very different in internal structure. Its cost would probably not exceed \$40,000.

*Taxidermists' Shop.*—Until recently the taxidermists have used a building of Mr. Rowley's in Berkeley as a taxidermists' shop, for which the Academy paid \$300 a year rent. Now that we have moved into the new museum building, it is necessary to have a work shop nearer at hand. A building is needed in which to store the animals, etc., which have not yet been prepared and to carry on all the preparatory work of the Department of Exhibits. It is estimated that such a building as is required, together with proper equipment, could be built for \$1500. It would be located in the rear of the present building at a place acceptable to the Park Superintendent.

*Exhibits.*—It is highly desirable that the habitat groups in the two exhibition halls be put in place at an early date. The large habitat groups for which space has been provided should be installed as rapidly as possible. The same should be done with the small habitat groups of mammals and birds.



The preparation of small portable educational groups should be commenced and proceeded with as rapidly as the materials can be collected. Exhibits in other departments, as botany, entomology, herpetology, paleontology, geology, etc., should soon receive attention. Exhibits should not be limited to the departments of birds, mammals, and anthropology.

*Research Collections.*—Although the funds of the Academy are quite inadequate to meet its needs, to enable it to do much of that which it would like to do along the various lines of its legitimate activities it is important that none of its essential functions be even temporarily entirely abandoned. While most attention must for the present be given to the exhibition phase of museum equipment, the necessity for the enlargement of the research collections must not be forgotten. These collections should be enlarged by the addition of desirable specimens secured by purchase, exchange, donation and field collecting, and selected to meet the research needs of investigators. The several departments should be productive in scientific investigation and the study material must be provided. Such allotments of funds for field work and the acquiring of specimens should therefore be made as the income of the Academy will justify.

## APPENDIX TO THE DIRECTOR'S REPORT

## LIST OF ACCESSIONS TO THE MUSEUM, 1915

American Museum of Natural History, New York: Two meadow mice from Alaska; one chipmunk from Three Forks, Colo.; one white-footed mouse from Enterprise, and two meadow mice from Florida; two white-footed mice from Penobscot Co., Maine; two white-footed mice, two chipmunks, and one gopher from Fort Snelling, Minn.; one meadow mouse from Tobique River, and two shrews from Tronser's Lake, New Brunswick; two white-footed mice from Fairview, and one chipmunk from Newton, New Jersey; one pine squirrel from Alder Creek, one from Cornwall, three pine squirrels, one gray squirrel, two musk rats, two white-footed mice, one meadow mouse, one shrew, and one mole from Hastings, one jumping mouse from Lawyersville, one bat and one gray squirrel from New York City, two white-footed mice, two meadow mice, one shrew, and one pine squirrel from Nyack, one woodchuck from Tarrytown Heights, and one cottontail rabbit from West Orange, New York; one meadow mouse from Raleigh, North Carolina; two meadow mice from Rockport, and one from San Antonio, Texas; one meadow mouse from Haitland, and one pine squirrel from Linwood, Vermont; and four musk ox and one Peary caribou, collected by Lieutenant R. E. Peary in North Grant Land. Exchange.

Anaconda Copper Co., through Mr. E. P. Mathewson, Anaconda, Montana: Fifteen specimens of various ores, concentrates, etc.; two specimens of copper; three glass exhibition cases; two circular stands for exhibition; 18 framed photographs and diagrams illustrating smelting, with movable screens for exhibiting diagrams; all from exhibit at the Panama-Pacific International Exposition. Gift.

Anderson, F. M., California Academy of Sciences: Collections of shells, both recent and fossil, made at Gatun, Isthmus of Panama, and on the north coast of the United States of Colombia, with the assistance of Mr. Bruce Martin. Exploration.

Argentine Committee in Buenos Aires, for the Panama-Pacific International Exposition, through the Honorable Enrique M. Nelson, Vice-Commissioner General in Charge: Sixty-nine specimens of Argentine woods, and 86 packages of seeds of various species. Gift.

Arnold Arboretum, Jamaica Plain, Mass.: A collection of 1243 herbarium specimens, including 143 genera, 21 of which are new to the Academy's herbarium, and 730 species. Exchange.

Australia, Government of (New South Wales), through the Honorable Niel Nielson, Commissioner for New South Wales, Panama-Pacific International Exposition: Fourteen cases of ores; one block of bituminous shale; four mounted birds; 24 plaster casts of fishes; one Black-tailed Scrub Wallaby (*Macropus ualabatus*), mounted; one mounted Wombat (*Phascolomys mitchelli*); and seven large photographs of natural scenery. Gift.

- Australia, Government of (Queensland), through the Australian Commission, Panama-Pacific International Exposition: Ten specimens of native woods. Gift.
- Baker, Dr. Fred and Dr. Charlotte, San Diego, Cal.: A collection of more than 1000 specimens of plants from Japan and the East Indies, consisting of 277 genera, and 498 species, and including one family, 65 genera, and 412 species that are new to the herbarium of the Academy. Gift.
- Barbour, Thomas, Cambridge, Mass.: One lizard from Cuba. Exchange.
- Blumer, J. C.: Four specimens of plants from Arizona. Gift.
- Bolton, A. L., California Academy of Sciences: One badger skull from Arizona. Exploration.
- Bolton, A. L., California Academy of Sciences: A collection of plants from the Mohave Desert and Arizona, including about 40 species. Gift.
- Bowman, Miss Agnes, San Francisco: Fifteen specimens of plants from the Grand Canyon of the Colorado. Gift.
- Breeze, Wm. F., San Francisco: A series of insects. Gift.
- British Museum, London: One hundred and fifty-five specimens of plants, 32 of which were collected by Dr. Frank in Ohio in 1835, and 123 by Leo Lesquereux. Exchange.
- Buttle, Mrs. Alvina, San Diego, Cal.: Sixteen specimens of plants from San Diego Co., Cal. Gift.
- California Fish and Game Commission, San Francisco: A set of quail's eggs. Gift.
- California, State of, through Mr. W. D. Egilbert, Commissioner General, Panama-Pacific International Exposition: Sixteen plate glass show cases with stands, and two large safes. An indefinite loan.
- Carlson, John I., California Academy of Sciences: One snake and eight lizards from Cochise Co., and one toad from Yuma Co., Arizona; two snakes, one lizard and one salamander from San Francisco, and five lizards, one tree toad, and two salamanders from Santa Catalina Island, Cal.; 12 lizards from El Paso Co., and seven lizards from Fort Bliss, Texas. Exploration.
- Carlson, John I., California Academy of Sciences: A collection of 184 specimens of plants from Arizona; 54 from Santa Catalina Island, Cal.; and 74 from Texas; many of the species being new to the herbarium of the Academy. Exploration.
- China, Government of, through the Honorable Chen Chi, Commissioner General, Panama-Pacific International Exposition: Eighty-eight specimens of woods; 165 specimens of minerals; 17 boxes of cocoons; three boxes of skeins of silk; specimens of silk worms in alcohol; specimens of 192 varieties of seeds; one pair of buffalo horns; 24 framed photographs of natural scenery; 135 glass jars, bottles, and large containers for exhibition material; and a miscellaneous lot of exhibition boxes, cases, etc. Gift.
- Chipman, Dr. E. D., San Francisco: One snake from Fresno Co., Cal. Gift.

- Cockerell, T. D. A., State University of Colorado, Boulder, Colo.: One bundle of specimens of plants from New Mexico. Gift.
- Combined Amusements Co., Panama-Pacific International Exposition, through Mrs. Nellie Waterhouse Dorne, San Francisco: Two aningas and one manatee from Florida. Gift.
- Coombs, Mrs. A. L., San Francisco: Seventy-four specimens of plants from Oregon. Gift.
- Cuba, Government of, through General E. Loynaz del Castillo, Commissioner General for Cuba, Panama-Pacific International Exposition: Section of a Cuban Fan Palm (*Calpothermum wrightii*); eight specimens of ores; one specimen of serpentine rock; and a specimen of asphalt. Gift.
- Dickerson, Dr. Roy E., California Academy of Sciences: Two snakes from San Francisco. Gift.
- Dorne, Mrs. Nellie Waterhouse, San Francisco: Specimen of a fossil tree from Arizona. Gift.
- Eastwood, Miss Alice, California Academy of Sciences: Two hundred and four specimens of plants from Bodega Point, Sonoma Co.; 16 specimens from Granada, and 225 from vicinity of King City, Monterey Co.; 20 specimens from Lagunitas, Marin Co.; 208 specimens from Mariposa and Merced counties; 123 specimens from Mount Diablo; 148 specimens from Mount St. Helena; 33 specimens from Point Reyes and Inverness; and 20 from San Leandro, Alameda Co.; 191 specimens of California grasses; 621 specimens of exotics cultivated in California; and 1110 mounted specimens from the Yukon-Alaska expedition. Exploration.
- Edmands, W. H., Lake, Cal.: One woodpecker, one screech owl, and two least bitterns. Gift.
- Evermann, Dr. Barton W., California Academy of Sciences: One snake and two lizards from Kern Co., Cal. Gift.
- Evermann, Dr. Barton W., California Academy of Sciences: Seventy-three specimens of plants from Kern Co., Cal. Gift.
- Farrell, Miss Margaret, San Francisco: Six specimens of Oregon woods from the "White Pine Home" at the Panama-Pacific International Exposition. Gift.
- Fauntleroy, Miss Sophie, Santa Barbara, Cal.: Fifteen specimens of plants from Mariposa Co., Cal. Gift.
- Gerrard, Edward, & Sons, London: Seventeen snakes from India; four turtles from Borneo; one tortoise from Madagascar; one lizard from New Zealand; and one tortoise from the Seychelles Islands, Africa. Exchange.
- Gester, Clark, San Francisco: A series of tertiary shells from Peru. Gift.
- Gray Herbarium, Cambridge, Mass.: A collection of 501 specimens of plants from Washington, Utah, and the eastern United States, and from Mexico, Philippine Islands, and Siberia. Exchange.

- Guatemala, Government of, through the Honorable José Flamenco, Commissioner General, Panama-Pacific International Exposition: Nineteen specimens of minerals; 19 specimens of native woods; specimens of fibre, cotton, wax, rubber, etc. Gift.
- Halton, Miss Harriet, Carmel, Cal.: Nine specimens of plants from Monterey, Cal. Gift.
- Henry, Prof. J. K., Vancouver, B. C.: A collection of plants from Vancouver, B. C., comprising about 120 specimens. Gift.
- Herring, J. P., California Academy of Sciences: Five jack rabbits, 13 white-footed mice, two coyotes, two southern California elk, and two elk skulls, from Buttonwillow, Kern Co.; three wood rats, four tree squirrels, one weasel, one shrew, two ground squirrels, 10 chipmunks, one mole, seven meadow mice, and one bat, from Mendocino Co., Cal. Exploration.
- Honduras, Government of, through the Honorable Timoseo Miraldo, Commissioner General, Panama-Pacific International Exposition: Thirty-four exhibition jars and bottles; 34 specimens of native woods; specimens of seeds, jasper, iron ore, etc. Gift.
- Hubbs, Carl T., Stanford University, Cal.: A collection of marine invertebrates from Pacific Grove, Cal. Exploration.
- Hurter, Julius, St. Louis, Mo.: Two turtles from Bayou La Battre, and one turtle from Mount Vernon, Alabama; one toad from Yavapai Co., Arizona; one lizard from Santa Catalina Island, Cal.; two lizards and one turtle from British Honduras; and two lizards and one turtle from Guatemala. Exchange.
- Idaho, State of, through the Idaho State Commission, Panama-Pacific International Exposition: Twenty-five specimens of ores; one specimen of Yew. Gift.
- Imperial University of Japan, Tokyo: A collection of Pleistocene, and a few Cretaceous, fossils, from Japan. Exchange.
- Japan, Government of, through the Honorable H. Yamawaki, His Imperial Japanese Majesty's Commissioner General to the Panama-Pacific International Exposition: Thirty-one sections of native bamboo; specimens of zinc ores; a quantity of zinc dust; four large water-color paintings representing the four seasons; and two glass show cases. Gift.
- Kaeding, Mrs. Mary C., San Francisco: One fish duck, one hoopie, and two kingfishers from Korea. Gift.
- Kusche, J. Aug., Eldridge, Cal.: A collection of forty-one specimens of plants from Alaska. Gift.
- Lehman, Mrs., White Pass, Alaska: Six botanical specimens from Alaska. Gift.
- Mailliard, Joseph, San Francisco: Two topotypes of the Kern Redwing (*Agelaius phoeniceus aciculatus*) from Kern Co., Cal. Gift.
- Martin, Bruce, Cartagena, Colombia, S. A.: A collection of insects from the United States of Colombia, S. A. Gift.

- McAllister, M. Hall, San Francisco: Three young Golden Beavers (*Castor subauratus*), taken in the Suisun marshes, Cal. Gift.
- McAtee, W. L., Washington, D. C.: Seventeen specimens of plants from Washington, D. C. Gift.
- McClellan, J. Ellis, Fort Worth, Texas: One lizard from Fort Worth, Texas; and one lizard from Juarez, Mexico. Gift.
- McDonald, Miss Julia, San Francisco: A collection of plants from Fresno Co., Cal., comprising about 90 specimens. Gift.
- McGuire, Ignatius W., California Academy of Sciences: One snake from Marin Co., Cal. Gift.
- Meiere, Mrs. Ernest, San Francisco: Three specimens of plants from northern California. Gift.
- Milvain, Miss Margaret, Dawson, Yukon: Thirteen botanical specimens from Alaska. Gift.
- Missouri, State of, through the Commissioner General, Missouri State Commission, Panama-Pacific International Exposition: Twenty-six specimens of minerals; one cotton plant. Gift.
- Murphy, R. C., Brooklyn Museum, Brooklyn, N. Y.: Two lizards from Mexicali, Lower California. Gift.
- New York, State of, through Mr. Daniel L. Ryan, Secretary, New York State Commission, Panama-Pacific International Exposition: Thirteen exhibits of garnet powders and sands, and three specimens of minerals. Gift.
- New Zealand, Government of, through the Honorable E. Clifton, Commissioner General, Panama-Pacific International Exposition: One lizard (*Sphenodon punctatus*), from New Zealand. Gift.
- Norway, Government of, through the Honorable Consul F. Herman Gade, Commissioner, Panama-Pacific International Exposition: Two cases containing exhibits of paper making, and two tables. Gift.
- Oregon, State of, through the Honorable Oscar E. Freytag, Oregon State Commission, Panama-Pacific International Exposition: Twelve specimens of various Oregon woods. Gift.
- Pack, Herbert, Salt Lake City, Utah: Eleven snakes from Morgan Co., eight frogs from Cache Co., and eight frogs and two salamanders from Salt Lake Co., Utah. Gift.
- Phelps, Mrs. Kate Eastwood, Denver, Colo.: A collection of ninety-five specimens of plants from Colorado. Gift.
- Porto Rico, Government of, through the Honorable Martin Traneso, Jr., Acting Governor of Porto Rico, and Mr. E. T. Hull, Manager Porto Rico Coffee Exhibit, Panama-Pacific International Exposition: A relief map of Porto Rico; nine framed photographs of Porto Rican natural scenery; and one wooden coffee mill and pestle. An indefinite loan.
- Rixford, G. P., San Francisco: Twenty specimens of plants from various localities in California. Gift.

- Rothschild, Hon. Walter, Thring, England: One fossil turtle carapace from Madagascar; one tortoise cast, Rotumah Islands; two tortoise casts, Seychelles Islands, Africa; and three casts of carapaces, and two tortoise casts, localities unknown. Exchange.
- Rowley, John, California Academy of Sciences: Five Steller's sea lions from Año Nuevo Islands; and striped skunk for group, from Monterey, Cal. Exploration.
- Rowley, John, California Academy of Sciences: Three roadrunners, one flicker, two red-tailed hawks, and one ferruginous rough-legged hawk, from Kern Co., two mountain quails and one fox sparrow from Mendocino Co., Cal. Exploration.
- Ruddock, Geo. T., San Francisco: Twelve specimens of plants from Arizona. Gift.
- Sacramento Valley Counties Association, through the Sacramento Valley Commission, Panama-Pacific International Exposition: Forty-four specimens of minerals. Gift.
- San Joaquin Valley Counties Association, through Mr. Walter C. Maloy, Assistant Manager San Joaquin Valley Exhibit, Panama-Pacific International Exposition: Three hundred and six specimens of minerals, gold, silver, lead, zinc, copper, and iron ores, flint, asbestos, etc.; specimens of box woods; 57 specimens of various California woods; five specimens of petrified wood. Gift.
- Seitz, Mrs. A. R., Beaumont, Cal.: Seven specimens of plants from Riverside Co., Cal. Gift.
- Simson, Leslie: Two moose, three caribou, three mountain goats, three mountain sheep, and four brown bears from Alaska. Purchase.
- Sisson, L. H.: One weasel from Alturas, Cal. Gift.
- Slevin, J. R., California Academy of Sciences: Six snakes, 20 lizards, 11 toads, 119 tree toads, 14 frogs, and two salamanders from Los Angeles Co.; 70 snakes, 175 lizards, six toads, one tree toad, five frogs, and two turtles from San Diego Co.; and one lizard from Lower California. Exploration.
- Smith, L. E., Sisson, Cal.: A collection of specimens of plants from northern California, comprising about 130 specimens. Gift.
- South Dakota, State of, through Mr. Charles McCaffree, Commissioner of Immigration: Six specimens of ores from the Homestake Mine, from exhibit at the Panama-Pacific International Exposition. Gift.
- Sperry Flour Co., San Francisco, through Mr. B. D. Ingalls, Manager Sperry Exhibit, Panama-Pacific International Exposition: Four millstones. Gift.
- Standard Oil Co., San Francisco: A relief map of California showing oil fields; two panoramas in oil tanks illustrating the drawing and refining of oil; diagram of section of an oil field showing oil bearing strata; diagram of section of an oil well; 35 jars of asphalt in block, with four glass models showing materials in block; 11 legends for use in exhibition; and eight diagrams, with stands; all from exhibit at Panama-Pacific International Exposition. Gift.

- Stark, Dr. E. T., San Francisco: A series of minute fossils from the Midway Oil Field, California. Gift.
- Sweden, Government of, through the Honorable Richard Bernstrom, Commissioner General, Panama-Pacific International Exposition: Three cases of specimens of various minerals; exhibits of sugar products; a quantity of wood acid; and one exhibition glass case and stand. Gift.
- U. S. Bureau of Fisheries, through Dr. Hugh M. Smith, Commissioner, Washington, D. C. A large *Tridacna gigantea* on stand; eight specimens of American lobster; two glass jars containing fishes; 39 glass vials of embryo fishes; eight swordfish "swords"; plaster cast of the head of a blackfish; one case exhibit of young oysters on net; nine "saws" of sawfishes; four jars containing specimens of lobsters; one fur-seal group and base; two live alligators; 14 live turtles; one live frog; one stuffed alligator; five jawbones of sharks; 10 jars of fish glue; 64 jars of fish oil; five specimens of fossil shells; 15 jars fish products; 20 jars of whale bone and salmon fertilizers; one eel pot; three lobster pots; one skate of halibut trawl; four buoys for halibut; haddock and cod trawls; wicker eel pot; one Pacific Coast trawl line; model of Cail Fishway and stand; bundle of isinglass; three tables; two unit cases; 33 pieces of balene; small angling case complete; and containers for oil and fertilizer; all from exhibit at the Panama-Pacific International Exposition. An indefinite loan.
- U. S. Geological Survey, through Dr. George Otis Smith, Director, Washington, D. C.: Twenty-three specimens of minerals; specimens of ores, coal, etc. Gift.
- U. S. National Herbarium, Washington, D. C.: Four hundred and eighty-five specimens of plants from Mexico, the species all new to the herbarium of the Academy. Exchange.
- Van Denburgh, Dr. John, California Academy of Sciences: Six snakes from El Dorado Co., one lizard from Plumas Co., one lizard from San Mateo Co., four snakes, five lizards, two tree toads, 10 frogs, and 42 salamanders from Santa Clara Co., one snake and six lizards from Tehama Co., Cal.; and four lizards from Washoe Co., Nevada. Exploration.
- Van Dyke, Dr. E. C., California Academy of Sciences: A series of insects from Lake Tahoe, California. Exploration.
- Washington, State of, through Mr. Charles G. Heifner, Executive Commissioner, Panama-Pacific International Exposition: Eighty-five specimens of various minerals; and two specimens of woods. Gift.
- Webb, Miss Zelia, Campo, Cal.: Two snakes from San Diego Co., Cal. Purchase.
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# INDEX TO VOLUME V, FOURTH SERIES

New names in **heavy-faced type**; Synonyms in *italics*.

- Abies douglassi*, 189  
*grandis*, 189, 140, 146, 156  
 Accessions to the Library (1914), 5, 81  
 Accessions to the Library (1915), 222, 228  
 Accessions to the Museum (1914), 2, 28  
 Accessions to the Museum (1915), 215-221  
*Acila*, 42, 49  
   *gabbiana*, 50  
*Acropora*, *species*, 190  
*Acteon*, n. sp., 48  
*alabamiensis contracta*, *Ostrea*, 178, 185  
   *Ostrea*, 188  
*albipes*, *Phenacomys*, 113, 117, 119, 132, 136, 152, 154, 156  
*alta*, *Dosinia*, 85  
*alternata*, *Cerithiopsis*, 43  
*alticosta*, *Venericardia*, 47  
*alticostata*, *Venericardia*, 174, 176, 180, 181  
*alveata*, *Amauropsis*, 43, 49, 51  
*Amauropsis alveata*, 43, 49, 51  
   *andersoni*, 43  
*Ambystoma tigrinum*, 100, 101  
*Amphissa eocenica*, 49  
   *packardii*, 49  
*Ancillaria brezli*, 47, 49  
   *elongata*, 43  
*Anderson, F. M.*, 7, 9, 16, 206, 207  
*andersoni*, *Amauropsis*, 43  
*andersoni*, *Macrocallista*, 42, 49, 54  
*Anomia ephippioidea*, 177  
*antiguensis*, *Goniastrea*, 190  
*Arborimus*, A New Subgenus of *Phenacomys*, 119, 156  
*Arca hornii*, 42  
*Architectonica cognata*, 43  
   *hornii*, 43  
*arenicolor*, *Hyla*, 100  
*armigera hellpriniana*, *Cornulina*, 178  
*Arvicola intermedius*, 136  
*ater*, *Sauromalus*, 100  
*Avicula pellucida*, 42  
*Bailey, Vernon*, 113  
*baileyi*, *Crotaphytus collaris*, 100, 102  
*Baker, Mrs. Charlotte*, 4, 209  
*Baker, Dr. Fred*, 4, 209  
*Barbatia morsel*, 42, 47, 49, 50  
   *species*, 39  
*Barnard, W. C.*, 1  
*barrowi*, *Pinna*, 42  
*Bascanion constrictor vetustum*, 100, 107  
   *flagellum frenatum*, 100  
   *teniatum*, 100, 107  
*bayerquei*, *Cyprea*, 43, 60  
*Bebb, Dr. William*, 113  
*bicarinata*, *Siphonalia*, 44, 50, 66  
   *Turritella uvasana*, 44, 58  
*biseriatus*, *Sceloporus*, 100  
*blakei*, *Perissolax*, 44  
*boreas*, *Bufo*, 100, 101  
*bottae*, *Charina*, 100, 106  
*Bovard, Prof. John F.*, 113  
*Brachiopoda*, 43  
*brezli*, *Ancillaria*, 47, 49  
*brewerii*, *Cardium*, 42, 47, 49, 51  
*Bryant, Dr. Harold C.*, 7, 200  
*Bufo boreas*, 100, 101  
   *lentiginosus woodhousii*, 100, 101  
   *punctatus*, 100  
*Buccinopsis parryi*, 169, 172  
*Bulla hornii*, 43  
*Bunnell, A. S.*, 113  
*Bursa cowlitzensis*, 49, 51, 64  
   *washingtoniana*, 49, 51, 64  
*Busycon* (?) *blakei*, 85  
*buwaldana*, *Fasciolaria*, 50, 73  
*Cadulus pusillus*, 43, 49, 51  
*californiana*, *Conus*, 43, 74  
   *Meretrix*, 85  
*californiana*, *Volutilithes*, 35, 74  
*California Valley Elk*, 12, 204  
*californica*, *Tellina*, 43  
   *Terebra*, 44  
*californicus*, *Evotomys*, 134  
   *Nyctilochus*, 44  
*Callisaurus ventralis*, 100  
*callosa*, *Neverita*, 57  
*Calyptraea excentrica*, 43, 49, 51  
*Camp, Charles L.*, 118  
*Campbell, Mrs. Marian L.*, 4, 209  
*canalifera elongata*, *Rimella*, 59  
*canalifera*, *Rimella*, 48  
*Cancellaria stantoni*, 43, 49, 51  
*Cantharus perrini*, 49, 65  
*Cardium brewerii*, 42, 47, 49, 51  
   *cooperii*, 42, 47, 49  
   *linteum*, 35  
   *olequahensis*, 42  
   *species*, 188  
*carlosensis*, *Spondylus*, 39, 43  
*Carlson, John I.*, 3

- Cassidaria washingtoniana*, 47 .  
     species, 188  
*catenifer deserticola*, *Pituophis*, 100,  
     107  
*celatus*, *Phenacomys*, 125  
*cellulosa*, *Orbicella*, 190  
*Cerithiopsis alternata*, 48  
*Cerithium pliciferum*, 178  
*Charina bottae*, 100, 106  
*Chorophilus nigrinus triseriatus*, 100,  
     101  
Christy, Prof. Samuel B., 1  
*Chrysodomus mucronata*, 66  
     *ruckmani*, 48, 65  
Clark, Geo. A., 7  
Clay, C. I., 118, 118, 188  
Clemens, Chaplain Joseph, U. S. A., 99  
*Cnemidophorus tigris*, 100, 105  
*cognata*, *Architectonica*, 48  
*cohnii*, *Nucula*, 70  
Coker, Dr. Robert E., 2  
*collaris baileyi*, *Crotaphytus*, 10, 102  
*conradiana*, *Macrocallista*, 40, 42  
*consobrinus*, *Sceloporus*, 100  
*constrictor vetustum*, *Bascanion*, 100,  
     107  
*contracta*, *Ostrea*, 184, 185, 186  
     *Ostrea alabamiensis*, 178, 185  
*Conus californiana*, 48, 74  
     *cowlitzensis*, 48, 47, 49, 51, 74  
     *hornii*, 48, 74  
     *remondii*, 48, 49, 51, 74  
     *sinuata*, 70  
     *weaveri*, 48, 49, 51, 74  
*cooperi*, *Nucula*, 42  
*cooperii*, *Cardium*, 42, 47, 49  
     *Ficopsis*, 61, 62  
*Corbula harrisi*, 42, 56  
     *hornii*, 42, 49, 50  
     *parilis*, 42, 56  
     *uvasana*, 42, 56  
     species, 47, 178  
*Cordia microptygma*, 68  
*Cornulina armigera heilpriniana*, 178  
*cortex*, *Ostrea*, 169, 178, 174, 179  
*costata*, *Cylichna*, 48, 47, 49, 51  
     *Exogyra*, 169  
*cowlitzensis*, *Bursa*, 49, 51, 64  
     *Conus*, 48, 47, 49, 51, 74  
     *Crassatella*, 47  
     *Crassatellites*, 49  
     *Ficopsis*, 48, 50, 51  
     *Hemifusus*, 47, 61  
     *Murex*, 48  
     *Nyctilochus*, 44  
     *Pecten*, 47, 49  
     *Ranella*, 48  
     *Surcula*, 44, 48, 50, 51  
*cowlitzensis*, *Lunatia*, 50, 57  
     *Nerita*, 50, 58  
*Cowlitz Phase of Tejon Group*, 47  
*Crassatella cowlitzensis*, 47  
     *uvasana*, 85  
     *washingtoniana*, 47  
*Crassatellites cowlitzensis*, 49  
     *grandia*, 42, 49, 50  
     *mathewsonii*, 42  
     *uvasana*, 42  
     *washingtoniana*, 49  
*crenulimarginata*, *Ostrea*, 181  
*Crepidula pileum*, 48, 49, 51  
*cretacea* (c.f.) *Lucina*, 42  
*Cristellaria*, 189  
*Crotalus oregonus*, 100, 109  
*Crotaphytus collaris baileyi*, 100, 102  
     *wializenii*, 100, 103  
*Cucullaea macrodonta*, 176  
*Cummins*, Prof. W. F., 165  
*cumulata*, *Lucina*, 42  
*Cylichna costata*, 48, 47, 49, 51  
*Cypraea bayerquei*, 48, 60  
     *mathewsonii*, 48, 60  
Dall, Wm. H., 8, 188  
Davidson, Prof. George, 2  
Davidson, Thos., 2  
Davis, Horace, 5  
*Dendrophyllia tejonensis*, 42  
*Dentalium stramineum*, 48, 49, 51  
Description of a New Subgenus (*Arborimus*) of *Phenacomys*, with a Contribution to Knowledge of the Habits and Distribution of *Phenacomys Longicaudus* True, by Walter P. Taylor, 111-161  
*deserticola*, *Pituophis catenifer*, 100, 107  
*diaboli*, *Semele*, 49, 55  
*dichotomos*, *Septifer*, 42  
Dickerson, Roy E., 9, 16  
     Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington, 33-98  
*dickersoni*, *Exilia*, 48, 50, 51  
     *Fusus*, 47  
*dilleri*, *Thracia*, 49  
*Diplodonta polita*, 49, 51  
*Distortix septemdentata*, 177  
*divaricata*, *Ostrea*, 177  
Dohrmann, F. W., 1  
*Dosinia alta*, 85  
     *elevata*, 42  
*douglassi*, *Abies*, 189  
*douglassii*, *Phrynosoma*, 100, 105  
*Drillia ornata*, 50, 71  
     *raricostata*, 48, 71  
     *ullreyana*, 48  
Dumble, E. T.:  
     Tertiary Deposits of Northeastern Mexico, 163-193  
Eastwood, Alice, 4, 7, 9, 15

- Eimbeck, Prof. William, 5  
*elevata*, Dosinia, 42  
*elongata*, Ancillaria, 48  
     *Rimella*, 50, 59  
*elongatus*, Sceloporus, 100, 104  
*eocenica*, Amphissa, 49  
     *Glycimeris*, 42  
     *Nassa*, 48  
*ephippioides*, Anomia, 177  
*Epitonium*, n. sp., 43  
*Escondido Beds*, 169  
*Eumeces skiltonianus*, 100, 105  
 Evermann, Dr. Barton W., 7  
     Report of the Director of the  
     Museum for the Year 1914, 11-31  
     Report of the Director of the  
     Museum for the Year 1915, 203-223  
*Evotomys californicus*, 184  
*excentrica*, Calyptra, 43, 49, 51  
*excentricus*, Galerua, 47  
*Exilia dickersoni*, 43, 50, 51  
     *harrisi*, 43  
     *perkinsiana*, 50, 51  
     *waringi*, 68  
*Exogyra costata*, 169  
 Farlow, Prof. W. G., 5  
*Fasciolaria buwaldana*, 50, 73  
*Fasciolaria io*, 72  
     *sinuata*, 43, 74  
     *washingtoniana*, 48  
 Fauna of the Type Tejon: Its Rela-  
 tion to the Cowlitz Phase of the  
 Tejon Group of Washington, by Roy  
 E. Dickerson, 33-98  
*Favosites polygonalia*, 190  
 Ferris, Gordon F., 118  
*fettkei*, Melania, 50  
     *Ostrea*, 47, 49  
*Ficopsis cooperii*, 61, 62  
     *cowlitzensis*, 43, 50, 51  
     *hornii*, 43, 61  
     *remondii*, 43, 61  
*Ficus mamillatus*, 50, 61  
*ficus*, Whitneya, 44, 69  
 Fisher, Prof. Walter K., 118  
 Fitzhugh, W. M., 2, 196  
*flagellum frenatum*, Bascanion, 100  
 Franklin, Prof. E. C., 199  
*frenatum*, Bascanion *flagellum*, 100  
 Fuchs, Chas., 1, 4, 9, 16  
*fuscipes fuscipes*, Neotoma, 147  
*fusiformis*, Nyctilochus, 44  
*Fusus dickersoni*, 47  
     *lewisensis*, 47, 50  
     *merriami*, 72  
     *tumidus*, 43  
     *washingtoniana*, 47, 50, 72  
     *willisi*, 50, 73  
 gabbi, Leda, 42, 49, 51  
*gabbiana*, Acila, 50  
*Galeodea tuberculata*, 43, 50, 51  
*Galerus excentricus*, 47  
 Gastropoda, 47  
 Gifford, Edward W., 7  
 Gill, Dr. Theo. N., 1  
*Glycimeris eocenica*, 42  
     *ruckmani*, 42, 52  
     *sagittata*, 42, 49, 51  
*Goniastrea antiquensis*, 190  
*Goniopora*, 190  
 Goodspeed, Dr. T. H., 118  
*graciosus*, Sceloporus, 100, 104  
*grahamiae*, Salvadora, 100  
*grandis*, Abies, 139, 140, 146, 156  
     *Crassatellites*, 42, 49, 50  
 Gray, Prof. Asa, 5  
 Green, Chas. E., 2  
 Greene, Prof. Edward L., 199  
 Grinnell, Dr. Joseph, 118  
*griseus*, Sciurus, 141, 146, 147, 148  
 Grunsky, C. E., 6  
     Report of the President of the  
     Academy for the Year 1914, 1-10  
     Report of the President of the  
     Academy for the Year 1915, 195-201  
 Günther, Dr. Albert, 199  
*gyrata*, Lucina, 42  
*hammondii*, Scaphiopus, 100, 101  
*hannibali*, Natica, 44  
*hannibali*, Urosalpinx, 50, 69  
*Harpa*, species, 184  
*harrisi*, Corbula, 42, 56  
     *Exilia*, 43  
 Hawver, Mrs. Elizabeth Parsons, 209  
 Heath, Dr. Harold, 7  
*hellpriniana*, Cornulina *armigera*, 178  
*Hemifusus cowlitzensis*, 47, 61  
     *lewisiana*, 43, 50  
     *lewisensis*, 47  
     *sopenahensis*, 47, 50, 67  
     *tejonensis*, 47, 50  
     *volulaeformis*, 67  
     *washingtoniana*, 47, 50  
 Hemphill, Henry, 3  
 Henshaw, H. W., 4, 118  
 Hilgard, Prof. Eugene W., 199  
 Holden, Prof. E. S., 1  
 Holladay, Mr. S. W., 199  
 Holmes, Dr. S. J., 7  
 Holway, Dr. Ruliff S., 200  
 Hooper, C. A., 1  
*hornii*, Arca, 42  
     *Architectonica*, 43  
     *Bulla*, 43  
     *Conus*, 43, 74  
     *Corbula*, 42, 49, 50  
     *Ficopsis*, 43, 61  
     *Lunatia*, 43, 48, 57  
     *Meretrix*, 40, 42  
     *Nyctilochus*, 44

- Psammobia*, 42, 49, 51  
*Venericardia planicosta*, 43, 49, 51  
 Hosmer, Mrs. Charlotte, 3  
 Hough, Dr. Walter, 199  
*houstonia*, *Turritella*, 177  
*howardi*, *Tellina*, 43, 55  
*humerus*, *Mytilus*, 35  
 Husing, John H. W., 1  
*Hyla arenicolor*, 100  
*Hypsiglena ochrorhynchus*, 100, 106  
*idriaensis*, *Ostrea*, 49, 51  
*inornata*, *Placunanomia*, 47, 49, 51  
*inornata*, *Pseudoliva*, 50, 62  
*intermedius*, *Arvicola*, 136  
     *Phenacomys*, 117, 120, 125, 128, 132  
*io*, *Fasciolaria*, 72  
*io*, *Sureula*, 44, 72  
 Jewett, Stanley G., 113  
*joaquinensis*, *Tellina*, 43  
 Jordan, Chancellor David Starr, 199  
 Kelly, Mrs. G. Earle, 209  
 Kennedy, W., 165  
*kewi*, *Nyctilochus*, 64  
 Kofoid, Prof. C. A., 7, 200  
*latimanus*, *Phenacomys*, 125, 126, 128, 131  
*lawsoni*, *Voluta*, 76  
*lecontei*, *Schizaster*, 42  
 Lectures (Academy), 6, 199  
*Leda gabbi*, 42, 49, 51  
     *uvasana*, 42, 51  
     *vaderensis*, 49, 52  
*lentiginosus woodhousii*, *Bufo*, 100, 101  
 Leuschner, Dr. A. O., 7  
*lewisiana*, *Hemifusus*, 43, 50  
*lewisensis*, *Fusus*, 47, 50  
     *Hemifusus*, 47  
 Library, Accessions to the, 5, 31, 222-223  
*luteum*, *Cardium*, 35  
 List (A) of the Amphibians and Reptiles of Utah, with Notes on the Species in the Collection of the Academy, by John Van Denburgh and Joseph R. Slevin, 99-110  
*longa*, *Tellina*, 49, 51  
*longicaudus*, *Phenacomys*, 111-161  
 Lowe, Prof. T. S. C., 2  
*Lucina cretacea*, 42  
     *cumulata*, 42  
     *gyrata*, 42  
     (*Myrtaea*), n. sp., 42  
     *nasuta*, 42  
*Lunatia cowlitzensis*, 50, 57  
     *hornii*, 43, 48, 57  
     *nuciformis*, 43, 50, 51  
     *shumardiana*, 57  
 McAtee, W. L., 199  
*Macoma*, species, 42  
*Macrocallista andersoni*, 42, 49, 54  
     *conradiana*, 40, 42  
     *vaderensis*, 49, 54  
*macrodonta*, *Cucullaea*, 176  
 Magee, Thos., 1  
*magister*, *Sceloporus*, 100  
 Mailliard, John W., 3  
*mamillatus*, *Ficus*, 50, 61  
 Manson, Dr. Marsden, 199, 200  
*Marcia quadrata*, 42, 49, 51  
 Martin, Bruce, 6, 9, 16, 39, 48, 207  
*martini*, *Neritina*, 50, 59  
     *Voluta*, 44, 76  
*mathewsonii*, *Crassatellites*, 42  
     *Cypraea*, 43, 60  
     *Olivella*, 44, 50, 51  
*Meandrina*, 190  
*Melania fettekei*, 50  
     *packardii*, 50, 60  
     *vaderensis*, 50, 60  
 Membership in the Academy, 1914, 1  
 Membership in the Academy, 1915, 199  
*Meretrix californiana*, 35  
     *hornii*, 40, 42  
     *olequahensis*, 42, 47, 49  
     *ovalis*, 40, 42, 49  
     *tejonensis*, 42, 53  
     *uvasana*, 35, 42, 53  
     species, 39  
 Merriam, Dr. C. Hart, 113  
*merriami*, *Fusus*, 72  
     *Spisula*, 42  
     *Venericardia planicosta*, 40  
*microptygma*, *Cordiera*, 63  
*Microtina*, 115, 155  
*Microtus*, 151  
     *orecadensis sandayensis*, 144  
 Miller, Gerrit S., 113  
*Mimomys*, 136  
*Mitra simplicissima*, 43, 75  
     *uvasana*, 43, 75  
     *washingtoniana*, 43, 50, 75  
*Modiolus ornatus*, 42  
*Molopophorus striata*, 67  
     *tejonensis*, 66  
*Monodonta wattsi*, 50  
*monolifera*, *Turris*, 44, 50  
*mooreana*, *Tellina*, 177  
*Morio tuberculatus*, 43  
*morsei*, *Barbatia*, 42, 47, 49, 50  
*Mortoniceras*, 175  
*mucronata*, *Chrysodomus*, 66  
*Murex cowlitzensis*, 43  
     *packardii*, 50, 69  
     *sopenahensis*, 43, 48, 50, 51  
*muricata*, *Pinus*, 139, 144  
 Museum, Accessions to the, 2, 28, 215-221

- Museum, Report of the Director of the, 11-81, 208-228
- Mytilus humerus*, 85
- Nassa coccinea*, 48
- packardii*, 48
- texana*, 177
- nasuta*, *Lucina*, 42
- Natica hannibali*, 44
- recurva*, 177, 184
- uvasana*, 44
- Naticina obliqua*, 44, 48, 50, 51
- Nelson, E. W., 118
- Neotoma fuscipes fuscipes*, 147
- Nerita cowlitzensis*, 50, 58
- triangulata*, 59
- Neritina martini*, 50, 59
- Neverita callosa*, 57
- secta*, 44, 50, 51
- weaveri*, 50, 57
- nigritus triseriatus*, *Chorophilus*, 100, 101
- Niso polito*, 50, 51
- nuciformis*, *Lunatia*, 48, 50, 51
- Nucula cooperi*, 42
- species*, 49
- Nummulites*, 189, 190
- Nuttall, Mrs. Zelia, 209
- Nyctilochus californicus*, 44
- cowlitzensis*, 44
- fusiformis*, 44
- hornii*, 44
- Kewi*, 44, 64
- sopenahensis*, 44
- washingtoniana*, 44, 50, 51
- species a*, 44
- obliqua*, *Naticina*, 48, 49, 50, 51
- ochrorhynchus*, *Hypsigena*, 100, 106
- Odostomia*, *sp. a*, 44
- species*, 44, 50
- olequahensis*, *Meretrix*, 42, 47, 49
- Olivella mathewsonii*, 44, 50, 51
- olympicus*, *Phenacomys*, 117, 122
- onca*, *Rana*, 100
- Orbicella*, 190
- cellulosa*, 190
- Orbitoides papyracea*, 189
- orcadensis sandayensis*, *Microtus*, 144
- oregonus*, *Crotalus*, 100, 109
- ornata*, *Drillia*, 50, 71
- Uta*, 100, 103
- ornatus*, *Modiolus*, 42
- orophilus*, *Phenacomys*, 117, 120, 122, 128, 132, 136, 152
- Osgood, Wilfred H., 118
- Ostrea alabamensis*, 183
- alabamensis contracta*, 178, 185
- contracta*, 184, 185, 186
- cortex*, 169, 174, 179
- crenulimarginata*, 181
- divaricata*, 177
- fettkei*, 47, 49
- idriaensis*, 49, 51
- pulaskensis*, 172, 176, 180, 181
- sellaformis*, 183
- species*, 39, 42
- ovalis*, *Meretrix*, 40, 42, 49
- packardii*, *Amphissa*, 49
- Nassa*, 48
- packardii*, *Melania*, 50, 60
- Murex*, 50, 69
- Papagallo Shale, 170
- papyracea*, *Orbitoides*, 189
- parallelus*, *Solen*, 42
- parietalis*, *Thamnophis*, 100, 108
- parilis*, *Corbula*, 42, 56
- parryi*, *Buccinopsis*, 169, 172
- Pecten*, 89, 184
- cowlitzensis*, 47, 49
- poulsoni*, 188
- Pelecypoda*, 47
- pellucida*, *Avicula*, 42
- Perissolax blakei*, 44
- Perkins, Senator Geo. C., 5
- perkinsiana*, *Exilia*, 50, 51
- perrini*, *Cantharus*, 49, 65
- petrosa*, *Volutilites*, 184
- Phenacomys*:
- List of works containing important material relative to the genus, 158-161
- Phenacomys albipes*, 118, 117, 119, 129, 132, 136, 152, 154, 156
- celatus*, 125
- intermedius*, 117, 120, 125, 126, 128, 132
- latimannus*, 125, 126, 128, 131
- longicaudus*, 111-161
- Phenacomys longicaudus* True, Distribution and Habits of, 136
- orophilus*, 117, 120, 122, 125, 126, 128-132, 136, 152
- olympicus*, 117, 122
- preblei*, 128
- ungava*, 125, 128
- Phrynosoma douglassii*, 100, 105
- platyrhinos*, 100, 105
- Picea sitchensis*, 139, 156
- pileum*, *Crepidula*, 43, 49, 51
- Pinna barrowsi*, 42
- Pinus muricata*, 139, 144
- pipiens*, *Rana*, 100, 102
- Pituophis catenifer deserticola*, 100, 107
- Placunanomia inornata*, 47, 49, 51
- planicosta hornii*, *Venericardia*, 43, 49, 51
- merriami*, *Venericardia*, 40



- Venericardia*, 47, 176, 177,  
 181, 182, 183, 184  
*platyrhinos*, *Phrynosoma*, 100, 105  
*pleurisepta*, *Sphenodiscus*, 169, 172  
*plicata*, *Thuja*, 141, 144  
*pliciferum*, *Cerithium*, 178  
*polita*, *Diplodonta*, 49, 51  
*polito*, *Niso*, 50, 51  
*polygonalis*, *Favosites*, 190  
*poulsoni*, *Pecten*, 188  
*Potamides*, species, 44  
*potopacoensis*, *Venericardia*, 182, 183  
*pretiosa*, *Rana*, 100, 102  
*Psammobia hornii*, 42, 49, 51  
 species, 42, 49  
*Pseudoliva inornata*, 50, 62  
*tejonensis*, 44, 63  
*volutaformis*, 44  
*Pseudoliva vetusta*, 184  
*Pseudotsuga taxifolia*, 139, 156  
*Publications of the Academy*, 5, 197  
*pulaskensis*, *Ostrea*, 173, 176, 180, 181  
*pulchra*, *Turris*, 50, 71  
*punctatus*, *Bufo*, 100  
*pusillanima*, *Turbinolia*, 40  
*pusillus*, *Cadulus*, 48, 49, 51  
*Putnam*, Prof. Frederic W., 199  
*quadrata*, *Marcia*, 42, 49, 51  
*Ramalina reticulata*, 146, 147, 157  
*Rana onca*, 100  
*pipiena*, 100, 101  
*pretiosa*, 100, 102  
*Ranella cowlitzensis*, 48  
*washingtoniana*, 48  
*raricostata*, *Drillia*, 48, 71  
*Rathbun*, Richard, 118  
*recurva*, *Natica*, 177, 184  
*remondii*, *Conus*, 43, 49, 51, 74  
*Ficopsis*, 43, 61  
*Tellina*, 43  
*Report of the Director of the Museum  
 for the Year 1914*, by Barton W.  
 Evermann, 11-31  
*Report of the Director of the Museum  
 for the Year 1915*, by Barton W.  
 Evermann, 203-223  
*Report of the President of the Acad-  
 emy for the Year 1914*, by C. E.  
 Grunsky, 1-10  
*Report of the President of the Acad-  
 emy for the Year 1915*, by C. E.  
 Grunsky, 195-201  
*reticulata*, *Ramalina*, 146, 147, 157  
*Rhynchonella washingtoniana*, 48  
*Rimella canalifera*, 48  
*canalifera elongata*, 59  
 elongata, 50, 59  
 simplex, 40, 44, 50, 51, 60  
*Rixford*, G. P., 4, 6, 7  
*Rowley*, John, 3  
*ruckmani*, *Chrysodomus*, 43, 65  
*Glycimeria*, 42, 52  
*sagittata*, *Glycimeria*, 42, 49, 51  
*Salvadora grahamiam*, 100  
*sandayensis*, *Microtus orcadensis*, 144  
*Sands*, J. M., 165  
*San Juan Limestone*, 170  
*Sauromalus ater*, 100  
*Scaphiopus hammondi*, 100, 102  
*Sceloporus biseriatus*, 100  
 consobrinus, 100  
 elongatus, 100, 104  
 graciosus, 100, 104  
 magister, 100  
*Schaeffer*, Ernest, 200  
*Schizaster lecontei*, 42  
*Sciurus griseus*, 141, 146, 147, 148  
*secta*, *Neverita*, 44, 50, 51  
*sellaformis*, *Ostrea*, 183  
*Semele diabolii*, 49, 55  
*semiannulata*, *Sonora*, 100  
*septemdentata*, *Distortix*, 177  
*Septifer dichotomus*, 42  
*Setchell*, William A., 118  
*Shelton*, Alfred C., 113, 118, 138  
*shumardiana*, *Lunatia*, 57  
*simplex*, *Rimella*, 40, 44, 50, 51, 60  
*simplicissima*, *Mitra*, 75  
*sinuata*, *Conus*, 70  
*Fasciolaria*, 43, 74  
*Surcula*, 44, 70  
*Siphonalia bicarinata*, 44, 50, 66  
*sutterensis*, 40, 66  
*sitchensis*, *Picea*, 139, 156  
*skiltonianus*, *Eumeces*, 100, 105  
*Slevin*, Joseph R. (with John Van  
 Denburgh):  
 A List of the Amphibians and  
 Reptiles of Utah, with Notes on the  
 Species in the Collection of the  
 Academy, 99-110  
*slevini*, *Voluta*, 44, 75  
*Slonaker*, Dr. J. Rollin, 7  
*Smith*, Dr. James Perrin, 7, 200  
*Smith*, L. E., 4  
*Snyder*, Prof. John O., 200  
*Solen parallelus*, 42  
*Sonora semiannulata*, 100  
*sopenahensis*, *Hemifusus*, 47, 50, 67  
*Murex*, 43, 48, 50, 51  
*Nyctilochus*, 44  
*Tritonium*, 48  
*Spaulding*, J. G., 1  
*Sphenodiscus pleurisepta*, 169, 172  
*Spirogyphus tejonensis*, 44  
*Spisula merriami*, 42  
*Spondylus carlosensis*, 39, 42  
*stansburiana*, *Uta*, 100, 103  
*stantoni*, *Cancellaria*, 43, 49, 51  
*Starks*, Prof. E. C., 200

- stramineum, Dentalium, 48, 49, 51  
 striata, Molopophorus, 67  
 Sucula cohnii, 70  
 Surcula cowlitzensis, 44, 48, 50, 51  
     lo, 44, 72  
     (Surculites) sinuata, 44, 70  
     uvasana, 71  
     washingtoniana, 44, 50, 51, 72  
 sutterensis, Siphonalia, 40, 66  
     Tellina, 49  
 teniatum, Bascanion, 100, 107  
 Tamaulipas Range, 166  
 Taylor, Dr. Walter P., 7, 200  
     Description of a New Subgenus  
     (Arborimus) of Phenacomys, with a  
     Contribution to Knowledge of the  
     Habits and Distribution of Phenacomys  
     longicaudus True, 111-161  
 taxifolia, Pseudotsuga, 139, 156  
 tejonensis, Dendrophyllia, 42  
     Hemifusus, 47, 50  
     Meretrix, 42, 53  
     Molopophorus, 66  
     Pseudoliva, 44, 63  
     Spiroglyphus, 44  
 Tejon Group, 35, 39  
 Tellina californica, 43  
     howardi, 43, 55  
     joaquinensis, 43  
     longa, 49, 51  
     mooreana, 177  
     remondii, 43  
     sutterensis, 49  
 Terebra californica, 44  
 Terebratulina washingtoniana, 49  
 Teredo, sp., 43, 49  
 Tertiary Deposits of Northeastern  
     Mexico, by E. T. Dumble, 163-193  
 Tevis, Lansing K., 3  
 texana, Nassa, 177  
     Volutomorpha, 169, 172  
 Thamnophis parietalis, 100, 108  
     vagrans, 100, 108  
 Thracia dilleri, 49  
 Thuja plicata, 141, 144  
 tigrinum, Ambystoma, 100, 101  
 tigris, Cnemidophorus, 100, 105  
 Todd, Aurelius, 113, 136  
 triangulata, Nerita, 59  
 Triforis washingtoniana, 50, 63  
 triseriatus, Chorophilus nigrinus, 100,  
     101  
 Tritonium sopenahensis, 48  
 tuberculata, Galeodea, 43, 50, 51  
 tuberculatus, Morio, 48  
 tumidus, Fusus, 43  
 Turbinolia pusillanima, 40  
     species, 42  
 Turris monolifera, 44, 50  
     uvasana, 44  
     species, 44, 50, 51  
 Turritella houstonia, 177  
     uvasana, 40, 44, 48, 50, 51  
     uvasana bicarinata, 44, 58  
         tricarinata, 44, 58  
     species, 44, 50, 51, 172, 181  
 ullreyana, Drillia, 43  
 ungava, Phenacomys, 125  
 Urosalpinx hanniball, 50, 69  
 Uta ornata, 100, 103  
     stansburiana, 100, 103  
 uvasana bicarinata, Turritella, 44, 58  
     Crassatella, 35  
     Crassatellites, 42  
     Meretrix, 35, 42, 53, 54  
     Natica, 44  
     tricarinata, Turritella, 44, 58  
     Turris, 44  
     Turritella, 40, 44, 48, 50  
 uvasana, Corbula, 42, 56  
     Leda, 42, 51  
     Mitra, 43, 75  
     Surcula, 71  
 vaderensis, Leda, 49, 52  
     Macrocallista, 49, 54  
     Melania, 50, 60  
 vagrans, Thamnophis, 100, 108  
 Van Denburgh, Dr. John, 6  
     A List of the Amphibians and  
     Reptiles of Utah, with Notes on the  
     Species in the Collection of the  
     Academy (Joseph R. Slevin, collab-  
     orator), 99-110  
 Vaughan, Dr. T. W., 190  
 Venericardia alticosta, 47  
     alticostata, 174, 176, 180, 181  
     planicosta, 47, 176, 177, 181,  
         182, 183, 184  
     planicosta hornii, 43, 49, 51  
     merriami, 40  
     potopacoensis, 182, 183  
     species, 188  
 ventralis, Callisaurus, 100  
 vetusta, Pseudoliva, 184  
 vetustum, Bascanion constrictor, 100,  
     107  
 voluteformis, Hemifusus, 67  
 voluteformis, Pseudoliva, 44  
 Voluta lawsoni, 76  
     martini, 44, 76  
     slevini, 44, 75  
     species, 44, 76  
 Volutilithes californiana, 35, 74  
     petrosa, 184  
     species, 44  
 Volutomorpha texana, 169, 172  
 von Geldern, Otto, 2  
 waringi, Exilia, 68  
 washingtoniana, Bursa, 49, 51, 64  
     Cassidaria, 47


Cramatella, 47	Wattsi, Monodonta, 50
Fasciolaria, 48	Wentworth, Coma, 43, 49, 51, 74
Fusus, 47, 50, 72	Severita, 50, 57
Hamifusus, 47, 50	Westlake, Capt. Ferdinand, 5
Mitra, 48, 50, 75	Weymouth, Dr. Frank W., 7
Nyctiolecha, 44, 50, 51	Whitneya frum, 44, 60
Ranella, 48	Wilder, H. K., 112, 113
Raynosaella, 49	Willitt, Fusus, 50, 73
Succinea, 44, 50, 51, 72	Wilson, Mr. J. C., 190
Terebratulina, 49	Wulfsberg, Ctenophorus, 100, 103
Washingtoniana, Tridacna, 50, 63	Woodhouse, Bala lentiginosa, 100,
Watson, Prof. Severa, 5	101









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